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// THE QUARTERLY JOURNAL OF THE FLORIDA ACADEMY OF SCIENCES

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SCIENCE, ETHICS AND EDUCATION[1]

SIGISMOND DER. DIETTRICH
University of Florida

The tumultuous forces of the atomic age have catapulted the men of science into greater dilemmas than ever before. At no other time in human history has knowledge offered such terrifying potentialities to a frightened mankind as the ever increasingly effective and efficient atomic weapons of various shapes, sizes and designs. Abstract mathematical formulas can tell positively the energy released in their explosions, costly experiments give detailed data about their destructive effects for scientific investigation. Yet even in the physical world one cannot foretell the impacts of a potential atomic war; how about the effects of such an Armageddon upon the biotic world and upon human society?

Western civilization may be characterized by its uncanny ability of applying scientific knowledge to human affairs. Unfortunately, too often the application means more efficient murder on the large scale. Explosive powder was known to the Chinese and used in firecrackers to celebrate birthdays and other festivals. It required western mentality to use it as gunpowder. The balloon, TNT, the tank, the submarine, the aerial weapons and the alphabetic bombs illustrate the point.

Of course there are always optimists who hope that the terrifying efficiency of a new weapon or of a potential weapon will bring man to his senses. But, alas, so far they have always been rudely disappointed as Benjamin Franklin was. When witnessing the first trial ascent in a balloon he figured out that any king who could procure a large enough squadron of these carrying a number of bombs could annihilate any besieged city. This was such a

[1] Presidential Address, Florida Academy of Sciences.

horrible thought, he argued, that when man realized its significance, he would live in everlasting peace. The balloon certainly did not stop warfare. Neither did the really efficient and deadly bomber plane serve that purpose, but after Hiroshima, the Pacific explosions and the H-bomb what now?

The terrifying prospects of a well-nigh annihilation of western civilization made everyone wonder. The question which had been asked before was raised anew and in a much stronger voice: "Was it morally right for a scientist to carry his studies so far as to give into the hands of mankind such a fearful weapon as the atomic bomb?" The Oppenheimer case helped forcefully to focus the Nation's attention upon this question. The case itself is involved and complex, the details of it unknown to the public, thus one cannot judge that case in particular. But the question transcends mere personalities and has to be investigated in the abstract.

Dr. Edward Teller in an interview by *Newsweek,* August 2, 1954 remarked:

> "In regard to the argument that development of the H-bomb was immoral, I felt only that there must be a clear-cut distinction between scientific and technical questions, on the one hand, and questions of morals and politics, on the other. Someone working on these things does have a dual role—first, he is a technical person, trying to do a good piece of work; second, he is also a human being and a citizen, and he would prefer that dangerous things do not exist. However, I feel very clearly that questions about whether these weapons should be made and whether they should be used are questions which, in the last analysis, are up to every citizen in a democracy, and, in the case of secret work, up to their representatives and proper government agencies.
>
> I believe that the person who makes the bombs is not quite the proper person to know what to do with them. . . ."

Dr. Teller's argument is that (1) the production of the H-bomb was a technical question that had to be solved on a scientific basis; (2) as a scientist it was his and his colleagues' duty to do a good job; ((3) the moral responsibility for making it in a democracy like ours rests with the citizenry and their proper governmental agencies and finally (4) that the man who made them "is not *quite the proper* person to *know what* to do with them". The inference in this latter being that the use of the atomic weapons is a military and political matter outside the scope of a scientist's responsibility.

Now comes the dichotomy: the scientist is also a human being and a citizen who "would prefer" that the bomb would not exist. By admitting such a dichotomy and expressing what I take as a pious wish for the nonexistence of such a dangerous weapon, Dr. Teller admits as a moral being he has his own qualms in the matter but apparently he has subordinated his moral ego to its scientist alter ego.

Oppenheimer on the other hand appears to have opposed the work on moral grounds. That is to say his moral ego imposed his will upon his scientist alter ego which resulted in an inner conflict with his colleagues and government agencies. Was he right, (of course it still has to be postulated that his decision was purely an ethical decision not inspired by any ulterior motive) or was he wrong, deserving the sarcastic epitaph that "he is ready to become another convert of a famous religious". This raises a footnote question, does it merit sarcasm when an eminent scientist in his hour of indecision and moral torment turns to God?

These conditions bring up the question of ethics and morality and their relationships to science. The problem bears investigation. While morality was based purely upon the magical or upon revelations of the supernatural there was a certainty of human conduct, at least there were the Ten Commandments and other revelations which served as a measure of human behavior. In ages when the magical or the revealed truths are not accepted, man loses the moral certainty of his actions and conflicts of internal and external nature are intensified until a new set of codes or a revitalization of the old ones takes place.

Since the Age of Reason, mankind in the Western World underwent the greatest revolutions known in history. These revolutions whether religious, political, literary, economic or scientific were merely so many facets of the same human development. They are indivisible and unintelligible if separated. The causality between these manifestations is so complex and involved that trying to trace them in their particularities seems academic pedantry. For the purpose of the present investigation only two phases will be analyzed: the developments in science and in ethics.

The freedom of thought and inquiry aided the development of experimental sciences. This resulted in the division of scientific fields, the rise of the specialists and a large degree of compartmentalization of human knowledge. Experimental science gave

rise to empiricism, empiricism to mechanisticism and to materialism. What could not be proven empirically could not be accepted as existing. Since only matter can be proven and matter appeared to behave mechanically, mechanical materialism became the proven form of scientific ideas.

These views were translated into human relationships and thinking as well. In philosophy Locke, Hume, the French Encyclopedists, destroyed the mind of man and reduced it to a mere registrant of sensual perceptions. "There is nothing in the mind except what was first in the senses" stated Locke. If matter is the only reality then the aim of man cannot be anything but the increased control of the material world. Technology supplied the means, capitalistic economy the framework for such a society. Rugged individualism, survival of the fittest class struggle provided the intellectual atmosphere in the chaotic world.

Hegel's concept depicting history as the struggle of ideas was borrowed by Karl Marx to substantiate his philosophy of dialectic materialism in his economic interpretation of history through class struggle. For the time being, as far as the western world was concerned, his materialistic interpretation of history was more significant or devastating than his economic theories. The former became a vogue among social scientists intensifying determinism, mechanisticism and environmentalism of which some of them could not free themselves.

Undeniably the material progress of the world was without precendent. The scientific progress was also immense. A lack existed only in the socio-ethical field. The development of political democracy required the spread of education. Education became a fetish but it did not turn out to be the savior of mankind. There are practically no illiterates left in the western world. Comics and pulp magazines are read by the millions. Their publication must be good business. For those who cannot or do not care to read, the movies, radio and television supply the means of information.

The fact that man has grown rich did not make him either better or more satisfied. Even if one does not quite agree with the pessimism of Werner Sombart there is much which is true in his statement when he declares:

> "We have already seen that we have become "rich"—so rich, indeed, in worldly goods as to be without a parallel in history. But it is precisely this wealth that has made us the slaves to our needs.

> If the capacities grew at a pace necessary to meet our demand for material goods, the demand itself would always be a nose-length ahead of the means to satisfy the demand. Much has awakened the wish for more. And an unsatisfied longing has entered the heart of mankind and gradually filled it more and more. A high and then an exaggerated emphasis on material things has taken hold, among high and low, and started the chase for enjoyment. For it seemed to be a psychological law that the increasing spell which the use of material goods has cast upon us, created a void within us which (until the great conversion) we attempted to fill by increasing the excitation charm of the senses. Thus wealth created out of itself that fundamental temper which we have accustomed ourselves to designate as materialistic. In the abundance of luxuries which has grown up about us, the ideal emotions of the heart find their natural grave. . . ." (1937, p. 34.)

An entirely different and in many ways surprising objection to the growing wealth at least of the United States is voiced by A. E. Wiggam in his "New Decalogue of Science". He is most concerned that in the America of the twenties so much wealth had accumulated that it enabled the nation to render health service, reducing infant mortality and disease rates. In this manner he implies that society interfered with the "natural" elimination of the weak and will undermine its racial structure committing, thereby, national suicide. Apparently he approves of the famines as the preservers of the "best" in humanity. Yet somehow India the classic home of famines does not substantiate his allegations. His commandments dealing with man based upon the naive belief in the "perfect" savage corrupted by society seem to represent the height of mechanical materialism.

When prosperity ended in failure, when the unlimited possibility turned out to be quite limited, the world got a breathing spell. People had nothing to do and some of them turned to contemplation. Science has learned a lot more new facts and had to produce new theories. Though at the turn of the century everybody knew the distinction between matter and energy, one had to relearn his scientific three Rs: matter and energy are different manifestations of the same principle and the possibility of the A-bomb was born.

In the fields of philosophy and ethics as well as in the social sciences the effects of man's new-found knowledge and wealth wrought great changes and played some havoc. If only the empirically provable material exists, then neither revealed, inspired or *á priori* conceived ideas can have validity. Thus, these cannot

serve as a basis for ethics which left the morality of the world in a somewhat peculiar, well-nigh confused, condition. Indeed the most extreme form of rugged individualism motivated by an untrammelled profit motive was not only a forcefully dynamic attitude but a diabolical manifestation of anti-ethics. Its path was strewn by pauperized "widows and orphans", by eroded, gully-scarred face of the land, by wastefully destroyed resources. In its hurried grab for money this modern Moloch, with his "robber barons" for high priests, tried to mow down any obstacle that may have risen between him and his ultimate goal of ruthless power and absolute domination through the monopolistic control of wealth.

A humanized ethics, with its watered-down Golden Rule, could not check such a force. The thunderbolts of Mt. Sinai were gone, but the brutal force of mass humanity remained. The lesson of the patriarch Jacob was well remembered. The force of the united weak-ones ultimately matched that of the ruthless giants and "rugged individualism" together with its henchman "unlimited profit motive" started on his retreat into oblivion.

The realization of social existence and of the consequent societal responsibilities strengthened the need for social ethics and societal morality. But societal existence is that state of affairs where every member is related to and dependent upon every other member of its own society. The almost completed breakdown of isolation permitted for the first time the development of a world-wide phase of civilization. Consequently each society, similarly to its members within itself, became related to and in varying degrees dependent upon every other society of this newly manifested global order.

Still borrowing from physical and biological sciences the interpretation and explanation of human life and values was heavily fraught with mechanistic, organistic, and relativistic concepts and terminology. Though one can hardly object to the borrowing and application of similes in the various fields of science and philosophy there must be a limitation beyond which no comparison can remain valid. Furthermore, it always has to remain a postulate that the borrowed concepts and terms are *like* but *are not* the ones under investigation. Learned discussions will otherwise continue to be produced treating boundaries as the epidermis of the state.

Inexact thinking often lead to the confusion of the "like" with the "to be" which was not helped by pragmatic utilitarianism either.

In effect it formed the basis for the development of a particularized ethics with a multiple system of standards, each relative to, i.e., suited to the demands of a specific profession or occupation.

These deep-seated turbulences of thinking, the rapidly increasing accumulation of factual knowledge and the societal evolution of the modern democratic state all impinged upon education as well. Classical education and rigorous training in the disciplines for those fit became anachronisms. Mass education for life became the battle cry. Mass education directed by statistical averages, aimed at the perception levels of just below the average, offering useful courses for credit and couched in psycho-scientific terminology in almost basic English produced literates by the millions. As a societal experiment, mass education was a phenomenal success. Yet rather early in its development, danger signs appeared such as the rapid decrease of student interest in "difficult" subjects such as mathematics, physics, chemistry or biology. Even a popularization of the subject matter was of little use. An erroneously conceived over-application of much needed integration lumped together various and sundry fields into popular "overviews", "cores" and other educational potpourris with disastrous results to the literates. The greatest fault of this type of mass education lies in the wasting away of the best minds. Letting bright students skip a grade or two cannot be the answer to the knowledge-thirsty minds of superior students. The time and effort that is devoted, often in a disproportionately high degree, to those who fall below the middle range students in mental capacity is another waste. Finally, such tenets as "education for life", "democracy in education" or "child motivated education" will need careful scrutiny, precise definition and complete reevaluation.

While well-meaning but aimlost integration held forth in the lower levels of education, education for life meant training in skills and techniques with pseudo-theoretical overtones for credits in the mushrooming specialized professional schools of higher learning. Specialization, in itself necessary and laudable, became enforced by the complexities imposed by the academic bookkeeping and its handmaiden the IBM machines. Convenience dictated that knowledge be compartmentalized and learning reduced to credits. Mass registration, the adulation of statistical means and averages, together with mathematically minded machines necessitated the attempt to create staffs of automatons. These, in the name of

uniform learning experience, all supposed to teach the same, test the same and achieve the same in the glory of the normal curve's percentile distribution.

That sarcastic voice of doom, Thorstein Veblen in his book "The Higher Learning in America" almost four decades ago forewarned of the results which will occur when what he called "corporations of learning" will have "set their affairs in order after the pattern of a well-conducted business concern". Lead by strong "captains of erudition" these "corporations of learning" will become "business concerns dealing in standardized erudition" (1918, p. 85). Whether one agrees or not with Veblen's bitter sarcasm, the undeniable fact remains that the administration of the American Universities is all too often entrusted to non-academic personnel. In addition not only the purely administrative phases of academic life but also the solely business aspects of the schools are elevated to a position of parity with the teaching staff and its purely academic organizations. These developments make one recognize just how correct were Veblen's assertions when he stated that:

> (1) ". . . these business principles primarily affect the personnel and the routine of instruction. Here their application immediately results in an administrative system of bureaux or departments, a hierarchical gradation of the members of the staff, and a rigorous parcelment and standardization of the instruction offered." (1918, p. 98.)
>
> (2) ". . . the instruction offered must be reduced to standard units of time, grade and volume. Each unit of work required, or rather of credit allowed, in this mechanically drawn scheme of tasks must be the equivalent of all the other units; otherwise a comprehensive system of scholastic accountancy will not be practicable, and injustice and irritation will result both among the pupils and the schoolmasters." (1918, p. 103.)
>
> (3) "The installation of a rounded system of scholastic accountancy brings with it, if it does not presume, a painstaking distribution of the personnel and the courses of instruction into a series of bureaux or departments." (1918, p. 105.)

This narrow, compartmentalized and over-specialized education for life ,could not have continued any longer than the over-generalized, over-integrated and over-socialized lower education, without strong critical objections being raised against it, like the remarks of Ortega y Gasset. In his "Mission of the University" he stated:

> "The man who does not possess the concept of physics (not the science of physics proper, but the vital idea of the world it has created) and the concept afforded by history and by biology, and the scheme of speculative philosophy, is not an educated man. Unless he should happen to be endowed with exceptional qualities, it is extremely unlikely that such a man will be, in the fullest sense, a good doctor, a good judge, or a good technical expert. But it is certain that all the other things he does in life, including parts of his profession itself which transcend its proper boundaries, will turn out unfortunately. His political ideas and actions will be inept; his affairs of the heart, beginning with the type of woman he will prefer, will be crude and ridiculous; he will bring to his family life an atmosphere of unreality and cramped narrowness, which will warp the upbringing of his children; and outside, with his friends, he will emit thought that are monstrosities, and opinions that are a torrent of drivel and bluff." (1944, pp. 60-61.)

The rationalistic, materialistic liberal *Weltanschauung* undoubtedly rendered a great service to mankind, at the same time, however, it unquestionably let loose such forces which, like Goethe's Zauberlehrling, it conuld not control. In every field of human endeavor it faced serious criticism and a searching reappraisal. Materialism was found wanting, rationalism was unable to answer all the questions and its simple negation of those which remained unanswered was unsatisfactory. A new philosophical frame of reference had to be invented.

The quest for truth is not finished and it probably never shall be as long as finite man is facing the infinite or maybe multiple infinites. Nevertheless, progress has been and is constantly being made. The *Sturm and Drang* of materialism widened greatly man's understanding of his world around him, especially in its material aspects. New truths have been discovered, scientific methods improved and a new technology invented. Now it seems necessary to make all these meaningful in an ethical, human world. Expressing it figuratively, the degradation of man by machines has to be stopped and the machines have to be placed in a position of partnership with their creators, the intelligent, etchical, mortal beings, men.

The guiding spirit is in ethics which according to Hans Driesch:

> ". . . must at least make the attempt to answer the question what ought to be done in each individual instance in accordance with its particular content, and why the course which is, in fact, adopted ought to be adopted to the exclusion of all other." (1930, p. 45.)

Furthermore:

> "There can be no ethics, and consequently there can be no particular moral doctrine, unless we assume some future supra-personal state which has been approved and is treated as our goal, whether it is the goal of an evolutionary process or not. . . ." (1930, p. 33.)

The latter postulates a dualism in the existence of the supra-personal and the personal state which form the totality of existence. Man himself is a psycho-physical person who possesses intuitive, *á priori* potential knowledge of ethical nature. This knowledge, however, requires stimulation from empirical experience in order to become realized. Ethics then deals with the "ought to be" and its relation to that which "is". Therefore, the supreme principle of theoretical ethics concerns the meaning of "good". Moral doctrine guides man in his attempt to realize the "ought to be", thus its supreme principle may be expressed in "thou shalt" or in "that which has been accepted as good must be realized".

Particular principles and axioms pertinent to this discussion are indeterminism, which, postulates free will and moral responsibility; one's duty towards his fellowmen which prohibts killing, bodily abuse or the infliction of any other, physical or mental harm; one's duty towards society and state, and society's and the state's duty towards its members and its counterparts.

Ethical principles and axioms are binding and by their nature no contradictions can exist between them. Man, however, being of a dual nature does not act always according to the moral precepts. In some of his actions, due to particular circumstances, though not acting according to moral precepts he may not have committed an immoral act because of different order of priorities. Such uses merit an *apology* which is not a condoning of the act but an expression of judgment implying that the act was "not good but less not-good" than its opposite would have been. Thus a man who killed may be accorded an apology.

What then, are the ethical relationships concerning science, scientist, and education? Science in the abstract is neither moral nor immoral. It is mainly a systematic attitude in the observation, compilation, description and classification of phenomena involving in addition to empirical experiences and experiments, the creation of hypotheses and the deduction of scientific laws and axioms. It is only when scientific principle are applied that a question of morality may arise. Thus, the pursuit of scientific investigation

should be left free. As a matter of fact deriving from the axiom of the duty of the state, state and society should not only guarantee the freedom of scientific inquiry, but also support fully, scientific study and research, since without adequate progress in the sciences society itself could not progress.

From the same duty arises the obligation of the state or society to supply adequate means of education for its people. Adequacy refers to quality and purpose, as well as to housing and equipment. Of these the first two are most important. The aim of the schools should be the total education of the students rather than a mere literacy and transmission of skills and techniques. In addition to the material aspects of learning, educators should most seriously be concerned with the moral aspects of society. Education for real life should offer the students experiences in discipline, impart to them appropriate responsibilities and challenge them with high standards of morality.

As far as quality of education is concerned, a quote from the "Encyclical Letter on Christian Education of Youth" of Pope Pius XI summarizes the problem most aptly:

> "Perfect schools are the result not so much of good methods as of good teachers, teachers who are thoroughly prepared and well-grounded in the matter they have to teach; who possess the intellectual and moral qualifications required by their important office; who cherish a pure and holy love for the youths confided to them, . . . and who have therefore sincerely at heart the true good of family and country." (1939, p. 63.)

The scientists' ethical obligation towards education is mainly twofold: first as teachers themselves it is their moral duty to give, according to their ability, the best instruction and example to their students; second, to be seriously concerned with the education of teachers. So much depends upon the teachers that even if one judges as somewhat exaggerated, Bismarck's remark that the German school teachers won for him victory over France it cannot be denied that in modern society the school and the teachers may have a stronger molding influence upon youth than in the home and parents themselves. Therefore, the quality of the teachers' education and the very aims of education should be of vital concern to everybody but especially to the scientists, since so much of the progress and welfare of society depends upon their work. If due to lack of proper preparation and inspiration the educational sys-

tem cannot produce a sufficient number of scientists and technically trained personnel the position of the nation in today's competitive world would become seriously impaired.

In the applied field the scientist is faced with this question. Does his work contribute to the killing of others? Here the intent must be the guiding element. Is the project meant to produce a weapon? If the answer is yes the scientist cannot evade his moral responsibility but an apology may be in order. If the project is sponsored by a state the responsibility of the state complicates matters. Weapons are made to be used in war to kill the enemy and destroy his homeland. Neither the killing nor the destruction can have moral approbations. However, one apology, analogous to the killing in self-defense, is valid if and when the enemy is known beyond reasonable doubt to want to annihilate the state, destroy its culture and civilization, and enslave its people. In such a case the ultimate defense of the superior culturo-ethical order by means of war fully merits a strong apology.

If the state coerces the scientist into such type of work it commits two sins: first the coercion in itself and second the purpose of coercion which both are immoral. Yet if a scientist accepts of his own will such a position with the government, he cannot shed his share of the responsibility. Conversely, if a scientist realizes his moral responsibility and withdraws from the project he acts completely within his moral rights and cannot be subjected to criticism on ethical grounds.

Since it cannot be questioned that the soviet form of atheistic communism is a total threat to the democratic ideals and societal institutions not only of the United States but also of the free world, a possible war with the Soviets would merit the strongest apology. Furthermore, if the cherished though somewhat naive hope that the terror of atomic weapons will prevent wars should really come true then the work of the scientists would have become of the highest ethical order. On the other hand if war were to come, moral beings including your speaker, will give their lives if necessary so that others may live which, too, is an act of the highest ethical order!

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VARIABILITY IN WILD AND INBRED MAMMALIAN POPULATIONS

Robert S. Bader
University of Florida

Introduction

The past several years have seen an increasing interest in and a greater appreciation of the characteristics of populations as opposed to those of individuals. This trend is apparent in the paleontological as well as the neontological approach to evolution. One of the most important of population characteristics is variability.

In a previous study, the writer (Bader, 1955), demonstrated a relationship between variability and evolutionary rate in two groups of oreodonts, extinct Tertiary artiodactyls. Intraspecific variability of the continuously varying osteological characters was found to be consistently lower in the phyletic line evolving at a more rapid rate. A greater selection pressure on the more rapidly evolving phyla was assigned the principal causative role with respect to the differential in variability. Haldane (1955), in reference to this study, suggested a correction factor for the variability in the very small samples. However, as he pointed out, the correction would not have altered materially the conclusions reached. Since transgressively varying osteological traits are the most consequential in the historical evolutionary record of the vertebrates, it seemed a matter of some importance to determine, for characters of this nature, the order of magnitude of the relative contributions of the two primary components of total variability, i.e., the heredity and the environment. These two components in quantitative (polygenic) characters have, in the past, usually been considered to have an additive relationship and to act essentially in an independent fashion as shown by the following equation of the variances (to which interaction terms are sometimes added):

$$\sigma_T^2 = \sigma_H^2 + \sigma_E^2$$

where σ_T^2 is the total (phenotypic) variance and σ_H^2 and σ_E^2 the contributions to the total variance of the heredity and environment respectively. The non-heritable portion may be further sub-

divided into intrinsic (developmental or intangible) and extrinsic (ecological or tangible) agents.

Patently, such an analysis could not be carried out on fossil material; therefore, the vertebrate paleontologist, as is so often the case, must turn to available neontological material from which inferences may be drawn. Inbred mammalian lines, in which the genetic component had been greatly reduced or was completely absent, seemed appropriate material for such an analysis. As is well known, intense inbreeding should theoretically reduce the heterozygosity in both plant and animal populations. In self-fertilizing species, the expected reduction is 50% per generation. Among mammals, in which the most intense form of inbreeding is brother-sister matings, the proportion of heterozygotes is reduced by 19% per generation. After approximately 20 generations of such consanguineous matings at least 99% of the population would be homozygous at a given locus, even though all were initially heterozygous at this locus. Families with this, or a longer history of inbreeding, could be expected to be essentially genetically uniform, disregarding, for the present, the action of disturbing factors. The reduction in the proportion of heterozygotes under brother-sister or parent-offspring mating systems follows the Fibonacci algebraic series (Jennings, 1916).

The experiment was designed to determine the decrease in phenotypic variability concomitant with the increased homozygosity of inbreds by comparing the variability of the inbreds with that of wild populations of the same species. The inbred variability should be primarily of an intrinsic environmental nature while that of the natural populations should have intrinsic and extrinsic environmental as well as hereditary components. Although any reduction in inbred variability could be assigned to a decrease in both extrinsic non-heritable and genetic factors, the results obtained place a rather definite upper limit on the magnitude of the reduction resulting from the elimination of the genetic component. The use of natural rather than laboratory populations for comparison with the inbreds has not (at least at the order of magnitude sought) vitiated the conclusions reached and offers a more meaningful analysis for naturalists desiring to estimate the general magnitude of the genetic variability in fossil or recent species. Although the inbreds may depart rather widely from natural conditions in terms of the physical and biotic environment, direction and intensity of

selection, and the nature of the reproductive pattern, the need for a greater control of the several variables more than justifies their use for comparison with the wild group. The inbred groups available for study included 3 species of mammals, all of which were rodents: *Rattus norvegicus, Mus musculus,* and *Cavia porcellus.* With respect to the wild populations, no attempt was made to estimate the variability of these taxonomic units as such; rather, all that was desired was a sample in each species collected from several localities to insure a genetically heterogeneous group with which the inbreds might be compared. The results are valid, of course, only within the limits of the sampling error. Only osteometric characters of the skull were considered since the post-cranial skeletal elements of the museum specimens were not retained.

Since, in biological material, the variance may be correlated with the mean (although the 2 statistics are mathematically independent), any measure of continuous variation should eliminate, as far as possible, the effect of the absolute size of the variate. Logarithmic scale transformation and the coefficient of variation are the most commonly employed methods. For this study the latter (V. = standard deviation (x 100)/mean)[1] was used since this has been the almost universally employed analytical tool of students estimating the variability in natural populations; thus, comparisons can more readily be made with data previously obtained from such groups. The coefficient of variation is (approximately) a function of the standard deviation of the logarithms of the variate. A meaningful comparison of the relative variation of homologous continuous variates can be made by the use of V only where the groups under consideration have a definitive adult state, e.g., the teeth and skeletal parts of mammals, or are represented by samples of uniform age. In some rodents, e.g., rats and mice, small size increments are added after the essentially adult state has been reached. This growth continues at ever decreasing rates throughout almost the entire life of the albino rat (Donaldson, 1919, King, 1923). Jackson (1913) reported very slow growth in the albino rat skeleton in 12 to 15 month old individuals. Individuals of the species, *Mus musculus,* continue to gain in body weight at least through 180 days although the percentage incre-

[1] The values obtained by the use of this formula were multiplied by $\left(1 + \frac{1}{4n}\right)$, the correction factor proposed by Haldane (1955).

ments drop sharply after about 70 days (Green, 1931). The modest size increase in the mature individuals has probably not appreciably affected the values of V in the wild members of the species. The criteria for selecting specimens of *Rattus norvegicus,* the species in which this effect is probably the greatest ,are given in the following section. Since the age of the inbreds is, in each case, known and almost certainly of a more uniform distribution than that of the natural groups, the relative variation of the wild forms would be increased to the extent that this factor is operative.

In addition to the more overt factors of age, sex, and nutrition, the following prenatal or early postnatal factors are also known to affect size in mammals (and, thus, variability if acting in a discriminate fashion within the population): age of the mother, quality of the mother's milk, length of gestation, position of implantation in the uterus, litter size, and season of birth. The specific effect of these last factors has not been considered in the present investigation.

The Measurements

The measures on the natural populations were made from specimens in the Chicago Natural History Museum. Both the wild and inbred populations have in every case an equal representation of the sexes and are (with the one exception noted below) composed of mature individuals. Nearly all of the measurements were made with a vernier caliper and were taken to the nearest .1 of a millimeter (a few variates, in which the mean was at or below 5 millimeters, were measured by an inside micrometer caliper and were taken to the nearest .01 of a millimeter). The measurements (not all of which were made on each species) and their abbreviations are as follows:

(1) Skull Length (Sk_L)—The distance from the anterior tip of the nasals to the dorsal rim of the foramen magnum along the midline

(2) Zygomatic Width (Zy_W)—The greatest width across the zygomatic arches on a line normal to the axial plane of the skull

(3) Paroccipital Width (Par Occ_W)—The greatest distance between the lateral edges of the paroccipital processes on a line normal to the axial plane of the skull

(4) Occipital Condyle Width (Occ Con_W)—The greatest width across the occipital condyles normal to the axial plane of the skull

(5) Diastema Length $Diast_L$)—The maximum distance between the anterior cheek tooth and the incisor, taken at the base of the teeth

(6) Interorbital Width (Io_W)—The minimum distance between the inner dorsal margins of the orbits normal to the axial plane of the skull

(7) Parietal Length ,Par_L)—The length of the parietal bone along the midline from the frontal to the interparietal suture of the left side

(8) Mandible Height (Jaw_H)—The distance between the top of the coronoid process and the lowermost posterior end of the mandible

(9) Mandible Length (Jaw_L)—The distance from the most posterior rim of the incisor alveolus to the lowermost posterior end of the mandible

(10) Palatal Length (Pal_L)—The length of the palate along the midline from the posterior edge of the palate to the posterior base of the incisor

(11) Parietal Width (Par_W)—The maximum width of the skull at the parieto-occipital suture

(12) Dental Length ($Dent_L$)—The maximum length of the cheek teeth series from the anterior edge of the first alveolus to the posterior edge of the last alveolus

(13) Temporal Width ($Temp_W$)—The maximum width of the cranium at the base of the temporal bone on a line normal to the axial plane

(14) Nasal Width (Nas_W)—The width of the nasal bones at the midpoint of their longitudinal axis

(15) Nasal Depth (Nas_D)—The vertical distance from the dorsal surface of the snout to the anterior end of the palate

(16) Palatal Depth (Pal_D)—The vertical distance from the posterior end of the palate to the dorsal platform of the skull

(17) Occipital Depth (Occ_D)—The vertical distance from the posterior edge of the basioccipital to the suture of mendoza at the midline

Comparative Analysis of Populations

A comparison of the coefficients of variation (V) for 9 skull measurements in wild and inbred populations of the Norway rat, *Rattus norvegicus,* is presented in Figure 1. The wild forms were collected in 1929 by H. Stevens from several localities in the Yunnan Province of Southwest China. All of the specimens measured were definitely mature as evidenced by the flat grinding surface of the molars, the prominent supraoccipital and parietal ridges, the flattened parietal region and the nature of the sutures. They would fall in the Group C of Gentile (1952). The inbreds had a history of at least 25 generations of consanguineous matings and were 250 days of age when sacrificed. They were being used as part of an analytical study of morphological intergration by Dr. E. C. Olson of the University of Chicago, who generously furnished the means and stanadard deviations. The sample size ranged from 20 to 24 for the various measures. The inbreds exhibit a lower variability in only 5 of the 9 comparisons (only 1 of which is significantly lower statistically, $P < .05$) while the wild rats have a lower V in the remaining 4, 1 of which is significant. There appears, then, the rather surprising result that a population long inbred, raised under laboratory conditions and homogeneous with respect to age has a variability entirely comparable to a population existing under natural conditions, genetically diverse, and with a somewhat less uniform age distribution. The mean ($\bar{x}$) of the 9 coefficients for the inbreds (5.00) is slightly below that of the natural group (5.21).

Figure 2 represents a similar comparison of populations of the house mouse, *Mus musculus.* The wild forms were taken from several localities in the Bengal Presidency area of India by H. Stevens in 1930-31. The inbred group were secured from the Argonne Cancer Research Hospital at The University of Chicago and were 9 months old, plus or minus 4 weeks. The inbred figures represent the mean of the coefficients of variation calculated separately, for 2 strains, A and Leaden. Strain A had a history of almost 100 generations of brother-sister matings while the Leaden group had been inbred for approximately 60 generations. The sample size ranged from 26 to 40. Of the 9 craniometric characters studied, the inbreds show a lower V in 6, 2 of which are significant, while the wild group exhibit a lower V for 3 traits,

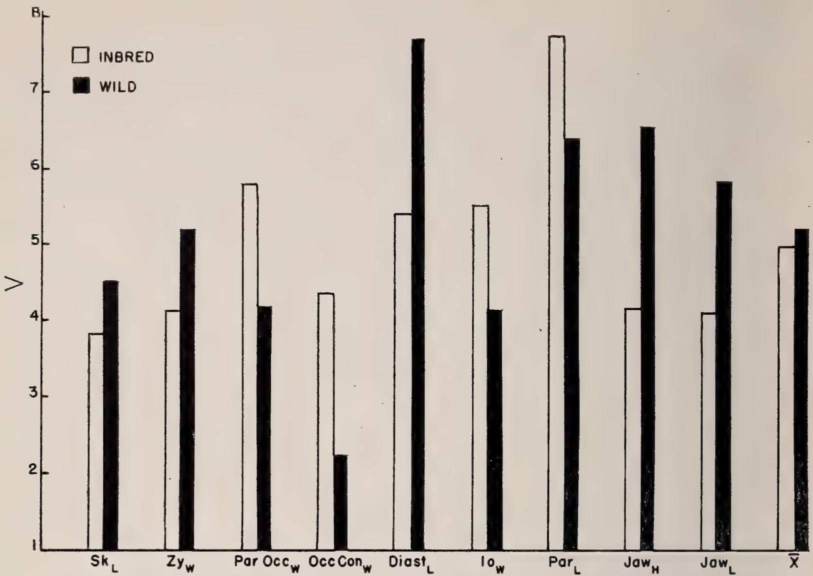

Figure 1. A comparison of the coefficients of variability (V) of inbred and wild populations of *Rattus norvegicus.*

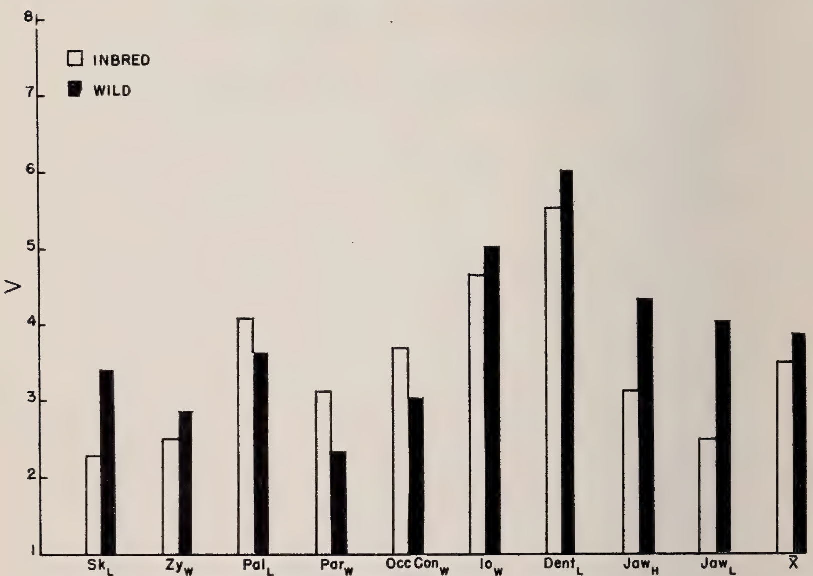

Figure 2. A comparison of the coefficients of variability (V) of inbred and wild populations of *Mus musculus.* The inbred figures represent the mean for two lines, leaden and A.

none of which are significant. The mean $(\overline{x})$ for the 9 coefficients is 3.51 (inbred) as opposed to 3.88 (wild).

Data for inbred, crossbred and wild populations of the guinea pig, *Cavia porcellus*, are presented in Figure 3. The wild population was obtained from several localities in South America including Peru, Uruguay, and Argentina, by C. C. Sanborn and W. H. Osgood during the years 1923-26. On the advice of Dr. Philip Hershkovitz, Chicago Natural History Museum, the name *Cavia porcellus* is used here for all wild living forms of the typical section of the genus and includes the formerly described species *C. tschudii*, *C. pamparum*, *C. aperea* and *C. rosida*. The sample size for the wild population varies from 28 to 32. The inbred figures (taken from Strandskov, 1942) represent the mean of the coefficients of variation of two families, lines 2 and 13. According to Strandskov, these rodents had been inbred (brother-sister) for 24 generations and were "considerably more than one year old". The sample size was 40. The inbreds have a lower V in 5 of the 8 characters (2 are significant) and the feral group a lower V for 3 traits, 1 of which is significant. The mean for the 8 coefficients is slightly lower for the inbreds (4.42 to 4.61).

The inbred families which Strandskov measured were but two among several which Sewall Wright had been maintaining for several years at the University of Chicago. About 1951, desirous of learning how specific genes would manifest themselves in association with a different genome, Wright crossed the various inbred lines more or less at random. This resulted in a genetically polygot population. Hill (1955) took, among others, the same skull measurements on this crossbred group that Strandskov had previously made on the inbred lines. The results are indicated by the cross-hatched bars in Figure 3. The inbreds exhibit a significantly lower V in 4 of the 8 measurements when compared with the crossbreds while the crossbreds are significantly lower in 3 of the measurements. The mean coefficient is only slightly lower for the inbreds (4.42 to 4.56). The V's computed from the 3 treatments (inbred, crossbred and wild) were tested by the analysis of variance, the results of which indicated that no significant difference existed between the populations.

Hill's sample was very large (150) but consisted of guinea pigs only 30 days old as opposed to adults in the other two groups. Olson (1955) studied the variability of 34 osteometric characters

in the albino rat in 4 stages of postnatal development (1, 10, 20, and 40 days) plus the adults (9 months). He found no secular trend in variability. King (1918) reported the highest variability in body weight of the albino rat at the 30 and 60 day stages. Jackson (1913) found the greatest V in rat body weight at the 20-day stage and also gave coefficients of variation for human body weight which indicated that the highest V's occurred at puberty. The effect of the disparity in age between the samples of Hill and Strandskov, if operative at all, has probably served to increase somewhat the relative variability of the younger group and thus would give additional emphasis to the generalizations propounded in the following section.

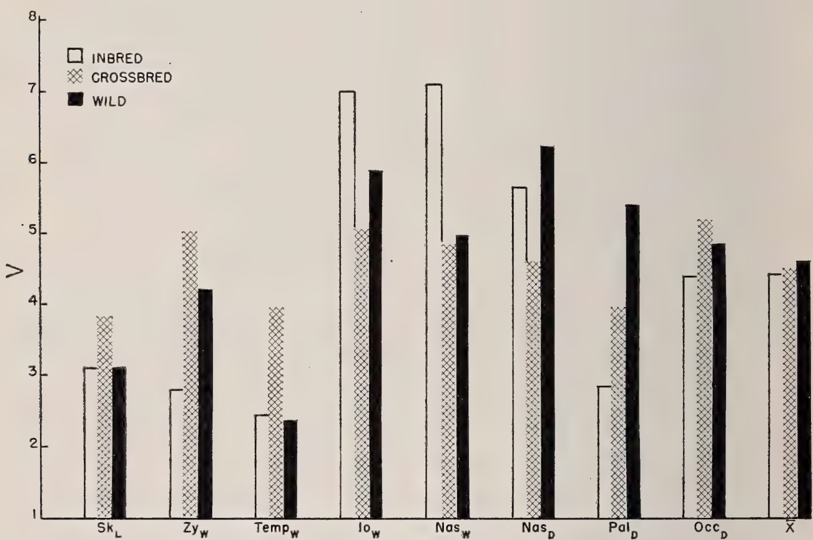

Figure 3. A comparison of the coefficients of variability (V) of inbred, crossbred and wild populations of *Cavia porcellus*. Inbred figures represent the mean for two inbred lines.

Discussion

The results of the comparative analysis of the variability in the wild and inbred populations are summarized in Table 1. Nine character comparisons were made in the Norway rat and house mouse and 8 in the guinea pig, a total of 26. Of these, 16 exhibit a lower V in the inbred line (only 5 of which are significant) while the remaining 10 show a lower V in the wild group (2 of

which are significantly lower). The 16 to 10 division does not differ significantly from a 1 to 1 ratio. It is seen that in each species the mean of the V's for the inbreds is slightly below that for the wilds. If real, this difference (and the preponderance of lower V's among the inbreds) can be readily ascribed to the more diverse extrinsic environmental conditions to which the natural populations were exposed. Here, the differential in nutrition within the feral group would probably constitute the most important single factor. Incorporating this differential of extrinsic factors in our deliberations, the inbred groups seem to be fully as variable, if not somewhat more so, than the natural assemblages. Evidently, in these groups and characters, inbreeding has not resulted in any appreciable reduction in phenotypic variability.

TABLE 1

A summary of the comparisons of coefficients of variation in wild and inbred populations. The figures in parentheses represent the number of statistically significant lower V's.

	Lower V in Inbreds	Lower V in Wilds	Mean V in Inbreds	Mean V in Wilds
Rattus norvegicus	5 (1)	4 (1)	5.00	5.21
Mus musculus	6 (2)	3 (0)	3.51	3.88
Cavia porcellus	5 (2)	3 (1)	4.42	4.61
Total or grand mean	16 (5)	10 (2)	4.31	4.57

These results demand a reinspection of the hereditary-environmental relationship to total variability discussed ini the introductory section. First of all, the question arises as to whether the theoretically expected genotypic results of continued consanguineous matings, i.e., increased homozygosity, correspond with those actually realized in practice. With respect to traits of a quantitative nature, the calculated expectations have never been empirically verified (Mather, 1951). There is some experimental evidence (Dobzhansky, 1951, Dobzhansky and Wallace, 1953, Dobzhansky and Levene, 1955, Düzgünes, 1950) that selection may favor heterozygotes over either of the homozygous combinations in which instance the reduction in homozygosity would be retarded (see, also Grüneberg, 1954). Hayman and Mather (1953) calculated the effect of selection against homozygotes on the progress of decreased heterozygosity for various types of consanguineous matings. For

sib matings, the homozygotes would have to be at a relative disadvantage of approximately 25% to prevent the eventual attainment of complete homozygosity although smaller disadvantages would delay the approach to genotypic uniformity. However, it is quite probable that the histories of inbreeding in the several groups here considered would be sufficient to insure the attainment of relatively high levels of homozygosity, although probably falling short of the calculated values. Population size and structure, immigration, selection, and mutation are all known to affect the genetic variability of a species. The extent to which these determinants have individually modified the variability in the natural populations under consideration is unknown. The genetiic variability of natural bisexual populations in general, except in unusual circumstances, is almost certainly quite high. Mayr (1954) has recently emphasized this point stressing particularly the role of immigration and coadapted gene complexes. We may assume then, with considerable confidence, that the genetic component of total variability is, indeed, appreciably smaller in the laboratory populations, and since the total variability in these populations is of the same magnitude as that of the wild groups, it follows that the environmental component must have increased as a consequence of the continued brother-sister matings. It seems evident, therefore, that the two components are not acting independently but that one (the intangible environmental factor) is a function of the other (the relative heterozygosity). Of the data adduced here, the relationship between the V's of the crossbred and inbred guinea pigs gives the best controlled documentation of this genetic-environmental interrelationship. Crossbreeding of the several inbred lines did not appreciably increase the mean variability of the 8 skull characters. Since all of the pigs were raised under laboratory conditions with no differential extrinsic factors known to be operative, the increase in heterozygosity in the crossbreds appears to have been accompanied by a decrease in the intangible effects of the environment.

Not infrequently one finds in the evolutionary literature a comparison of the variabilities of 2 or more closely related species which are similar in population size and in geographic and age distributions. In the past, the variability was usually estimated in a subjective fashion (in which case the estimate was frequently erroneous); more recently, statistical methods have been employed.

If species A is found to have a greater variability than species B, and if there are no obvious extrinsic factors operating differentially on the 2 species (and usually there are not, or at least are not identified as such), then, species A, being more variable, is said to be *genetically* more heterogeneous (or heterozygous). It is often further stated that species A is more "progressive", i.e., likely to give rise to several contemporaneous descendant species, and, most importantly, will be better able to cope with future environmental vicissitudes due to the potential store of variability present in the population. Contrariwise, species B, having a lesser variability, is said to be a genetically more uniform or homozygous group. It is less likely to undergo multiple speciation and in greater danger of extinction due to a paucity of different kinds of alleles in the population which, if present, might enable the species to "keep up" with a rapidly changing environment. In short, an inference is made as to the genetic nature of the population from the phenotypic variability. The evidence presented here would indicate that such inferences, at best, rest on more dubious grounds than previously supposed.

Whatever the relative contributions of the heredity and environment, the values of V of dimensional osteological characters in extant mammalian species almost invariably is included within a narrow band which has as its approximate limits, 2 and 8.[2] The interaction between the two components results in a total variability whose expression is rather closely restricted irrespective of the species or character considered. This can to a certain extent be attributed to the geometric, rather than arithmetic, cumulative effects of the several genes in the polygenic system, i.e., the effect of individual determinents varies in proportion to the effectiveness of the rest of the polygenic array. Taking cognizance of the fact that variability is so notably circumscribed, taxonomists can use (and in a few instances have used) V as a supplementary criterion of species validity. It should also be noted that the range of values of V for homologous variates in closely related species are usually even more restricted than the limits given above. For example, in the oreodonts (Bader, 1955), there was a much greater intraspecific range of non-homologous V's than interspecific range of

[2] Characters whose precise form is of little importance to the organism or degenerating characters, no longer under selective control, may exhibit considerably greater variability.

homologous V's, including even species in two subfamilies. The coefficient of correlation between the mean V's for 23 homologous traits in the two subfamilies was + .86. In other words, the factors peculiar to the character itself have a greater influence on the magnitude of the variation than factors common to all the characters within a given species. The same phenomenon has been observed in horses and opossums as well as the rodents of the present study. This may, in part at least, be a manifestation of the effect of different polygenic arrays (which probably broadly overlap) on the various skull characters, although, as noted above, such genetic inferences from the phenotypic variability must be made with caution. There is also some evidence, which will not be discussed in detail here, that the magnitude of V may be characteristically greater in some mammalian taxons (e.g., orders) than others. Variability in bird species is, in general, lower than that for mammals (Engels, 1940, Fisher, 1947, Baumel, 1953). Almost certainly, selection plays a major role in this correlation of variability and phylogenetic relationship.

Variability in Heterozygotes

In his stimulating book, Lerner (1954; reviewed by Dobzhansky, 1955, Mather, 1955, and Landauer, 1955) discusses several points to which the present article is addressed. His principal thesis, the salient features of which, as he states, have been proposed by previous workers, may be summarized as follows: mendelian populations as well as individuals are possessed of self-regulatory, homeostatic properties, the most probable causation of which is the greater fitness of the heterozygotes due to their superior buffering qualities. The better buffering of the heterozygotes (the physiological explanation of which remains unknown) results in individual

TABLE 2

An index of the relative variability in two inbred lines of *Mus musculus* and the F_1. The index is obtained by dividing the V of the F_1 (x 100) by the average parental V. (See text.)

Sk_L	Zy_W	Pal_L	Par_W	$OccCon_W$	Io_W	$Dent_L$	Jaw_H
98	77	80	99	82	83	100	86
Jaw_L	$Pelvis_L$	$Femur_L$	$Tibia_L$	$Scapula_L$	$Humerus_L$	$Ulna_L$	$Radius_L$
88	90	94	90	94	99	95	94

ontogenetic paths which have smaller deviations from the optimum for fitness. A great mass of data from various sources (primarily involving bisexually reproducing animals) is systematically reviewed by Lerner, most of which is favorable to the homeostatic hypothesis.

It follows from Lerner's several premises that the intrinsic environmental component of variability in heterozygotes, particularly for adaptive traits, should be lower than that in homozygotes. The results of the comparisons detailed above may best be accommodated by this deduction. However, the most crucial test, as Lerner pointed out, would consist of a comparison of the variability in strains long-inbred with that of their F_1. Since each group is theoretically genetically homogeneous, the variability should be entirely of environmental origin. Mather (1949) states "it has been generally supposed that where the non-heritable variance of F_1 differed from the non-heritable variance of the parents, it should exceed them." Unfortunately, this most important point has received little detailed attention from investigators. In order to test this hypothesis, LAF_1 mice as well as the inbred parents were obtained from the Argonne Cancer Research Hospital. As previously mentioned, strain A had been inbred for over 95 generations; the leaden strain inbred for approximately 60 generations. Both the F_1 and parental population were about 9 months of age. The sample size varied from 32 to 40. The same 9 cranial measurements as previously mentioned for the inbred-wild comparison were taken on the F_1 group and, in addition, 7 post-cranial measurements were made on both the hybrids and the inbreds. An index was obtained by dividing the V for the hybrids (x 100) by the average parental V. It is seen in Table 2, that, although several indices approach 100, none exceed it. The F_1 variability is, then, in every case equal to or less than the mean of the parental V's. The mean of the 16 indices is 90. Although the relation of these characters to fitness is not known, heterosis, which may give an indication of adaptive significance, is exhibited in 15 of the 16 traits considered, interorbital width being the exception.

Conclusion

A study of the literature reveals several instances in which the variability of inbred lines is equal to or greater than that of heterozygous assemblages, although until very recently this point has

rarely been stressed as such, evidently being considered an accident of sampling. Much of the previous work on mammals is discussed by Lerner (1954) and need not be repeated here. However, a few investigations, not mentioned by Lerner, merit a brief review since they deal with osteometric traits and yield results consistent with the present findings. Eaton (1938, 1939) obtained V's for the weight and linear measures of bones as well as for the weight of various internal organs of 3 inbred families of guinea pigs and their hybrids. In the majority of cases, for both hard and soft parts, the phenotypic stability of the hybrids was greater than that of the inbreds (although, it should be noted, some of the samples for females were very small). In the comparison with respect to linear bone measures, the variability of an outbred control group was lower than that of one of the inbred lines. Green (1931) crossed 2 inbred mouse species, *Mus musculus* and *Mus bactrianus*, in order to investigate the mode of inheritance of factors affecting size and growth. The present writer, combining the V's for the 2 sexes which were treated separately by Green, found the hybrids to possess a lower variability than the parental average in 9 of the 10 quantitative characters for which data were given. Six of these measurements were on the skull and post-cranial skeleton. Wexelsen (1937), reporting on the inheritance of 3 dimensional traits of the skeleton (beak, leg, and sternum) in pigeons, included a comparison of variabilities in the F_1 and parents. With few exceptions, the F_1 exhibited a lower variability than the parental average. Grüneberg (1952) noted several instances in which the inbred variability was higher than that of the F_1 for quasi-continuous skeletal abnormalities of the house mouse.

Recent evidence indicating a greater resistance to environmental change in heterozygotes with respect to physiological characters has been reported in *Drosophila* (Maynard Smith and Maynard Smith, 1954) and the house mouse (McLaren and Michie, 1954 and Yoon, 1955). The latter adds still another facet to the homeostatic mechanism by concluding "It appears not only the lack of heterozygosity in animals themselves leads to decreased resistance toward environmental changes but also the lack of heterzygosity in female parents leads to an unfavorable condition for the homeostatic function of these offspring." Robertson and Reeve (1952), finding a lower environmental variance in wing length of *Drosophila melanogaster* in the F_1 than in the inbred parents, interpreted the reduction

as due to the greater biochemical versatility of the heterozygotes. However, Tebb and Thoday (1954), on the basis of a study of the X-chromosomes of *D. melanogaster*, concluded that the degree of homeostasis exhibited by a population is not a function of the heterozygosity *per se* but rather due to the relational balance of the chromosomes established through natural selection. Lewis (1954) proposed a model, supported by botanical evidence, in which the variability of the F_1 bears a positive linear relationship to the degree of dominance of the genes concerned. Much more work is obviously needed, particularly with respect to natural populations, for a more complete understanding of the operational mechanisms of genetic homeostasis.. Regardless of whether the data presented here can ultimately be reconciled with a theoretical scheme such as Lerner's, the relative variabilities of the several groups should be of considerable interest to evolutionists.

The study of the theory of variability and the inheritance of quantitative characters is a particularly difficult problem. Since shortly after the turn of the century, the presumptive mode of inheritance of transgressively varying characters has been the multiple-factor (polygenic) hypothesis although this interpretation has not been without its dissentients (e.g., Sumner, 1923a, Castle, 1929, 'Espinasse, 1942). The supportive evidence for the multiple-factor hypothesis has consisted largely of the intermediate nature of the F_1 (when not augmented by overdominance), the increased F_2 variability (although this is not invariably the case; see, e.g., the data of Livesay, 1930, Eaton, 1938, 1939, and Grüneberg, 1952) and the theoretical adequacy of the factorial, i.e., mendelian, explanation. More recently, evidence has been adduced which demonstrates segregation and linkage in polygenic systems (see especially, Mather, 1949).

As regards the inheritance of dimensional skeletal traits, only rarely have specific genetic determinants been identified and unambiguously allocated to particular chromosomes; rather, studies in this most important area for the evolutionist have been marked by a considerable diversity of opinion as to the relative roles of general vs. specific size factors (Castle, 1924, 1924a, Sumner 1923, 1924, Wright 1932, and Strandskov, 1942). Among mammals on which genetical studies of the skeleton have been most extensively carried out (e.g., the mouse and rabbit), discontinuous anomalies,

as might be expected, have received the greatest attention (Grüneberg, 1950, etc., and Sawin, 1945, etc.). The heredity of skeletal characters exhibiting continuous variation remains virtually unknown.

One of the major difficulties in biometrical genetics, at present, is the selection of measurements, the genetic determinants of which act primarily on the character chosen. Grüneberg (1952), after a study of the inheritance of quasi-continuous variations in the skeleton of the house mouse, concluded that "the multi-factor inheritance generally encountered in quantitative genetics is due to the arbitrary choice of parameters which, for that reason, are only very indirectly influenced by the vast majority of genes". More recently (1955), he has suggested that the heritable variation in quantitative traits is not due to a separate class of genes (polygenes), each with its minute effect on the continuously varying character, but is better explained as due to the pleiotropic effects of a relatively small number of genes with major effects (oligogenes).

That the solution of problems of continuous variation has not kept pace with that of qualitative characters, whose study if more amenable to classical mendelian analysis, seems, in part, traceable to the slow development of the necessary methodology in statistics and experimental design and, in part, to the general reluctance of its practitioners to allow the subject to develop in its own, unique way (Mather, 1951). Since differences between species, both living and extinct, are, to a large extent, differences in characters genetically determined by polygenes, the need for new approaches to problems in this most interesting and intricate area is manifest. An elucidation of even part of these problems could have widespread ramifications, not the least of which may lead to a reevaluation of many assumed evolutionary relationships and processes as interpreted from the fossil record of the vertebrates.

Summary

An attempt was made to ascertain the relative contributions of the hereditary and environmental components of total variability of continuously varying osteological characters in selected groups of mammals. A comparative analysis of the variability in wild and inbred populations of 3 species of rodents, *Rattus norvegicus*

Mus musculus, and *Cavia porcellus* was made. The comparisons were designed to evaluate the degree of variability reduction as a consequence of inbreeding. Variability was measured by the Pearsonian coefficient of variation (V = standard deviation (x 100)/mean). The variability of the inbreds proved to be lower in only 16 of the 26 comparisons made. The mean value of V was only slightly lower for the inbred group in each of the 3 species analyzed. Since the extrinsic environmental factors which were operative on the natural populations could easily account for this slight differential in V, it was concluded that the long history of brother-sister matings in the laboratory group did not reduce the phenotypic variability in these osteometric characters. Essentially the same variability was found in cross-bred and inbred guinea pigs, all of which were raised under similar conditions in the laboratory. These results lend support to the general conclusion that the environmental component of variability increases as the genetic component is reduced. Thus the former, at least in its developmental aspect, is a function of the latter. Lerner (1954) suggested that mendelian populations as well as individuals may exhibit self-regulatory properties, i.e., homeostasis. One consequence of this thesis is the lower variability of an environmental origin to be expected in heterozygotes. This hypothesis was tested by comparing the variability of F_1 mice with that of the parents. It was found that in all 16 traits considered (15 of which demonstrated heterosis) the F_1 variability was equal to or less than that of the parents. Several previous studies, revealing data consistent with conclusions reached here, were reviewed. In conclusion, the general nature and complexity of the variability and inheritance of size characters was discussed.

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A COMPARATIVE OSTEOLOGICAL STUDY OF THE SKULLS OF THE MORAY EELS, *GYMNOTHORAX FUNEBRIS* RANZANI AND *GYMNOTHORAX MORINGA* (CUVIER)

Paul R. Burton
University of Miami

Introduction

The purpose of this study is not only to point out certain osteological characteristics of the skulls of the two species, but also to elaborate upon comparative differences. In the process of satisfying the above objectives an attempt has been made to supplement the study with certain pertinent extracts from the literature.

Acknowledgment is hereby made to Luis Rene Rivas, Associate Professor of Zoology at the University of Miami, for his enthusiasm and guidance in this study. Recognition should also be given Dr. Charles Lane, of the Marine Laboratory of the University of Miami, for his assistance in making the X-ray photographs; and to Mr. Al Pfleuger, noted Miami taxidermist, for making available a number of the specimens utilized in this work.

Methods and Materials

The total numbers of complete skulls of each species examined in this study were: *Gymnothorax funebris*—6 and *Gymnothorax moringa*—8.

Several of these skulls were obtained from Mr. Al Pfleuger in a skeletonized state and therefore the total length of the fish could not be ascertained. It could be assumed from the size of the skulls however, that they were from specimens generally approaching the maximum total overall body lengths indicated by Breder (1929) and Beebe and Tee-Van (1933). The maximum known overall body length of any specimen of *Gymnothorax funebris* was 56 inches, while the minimum overall length of any known specimen was 39 inches. The maximum in *Gymnothorax moringa* was 35 inches, and the minimum 19 inches.

Comparison and study of bones was aided by a binocular microscope and a hand lens. X-ray photographs were also made of both ventral and lateral views of each species so as to facilitate study of the bones in their natural and relative positions.

Comparative Osteology

Discussion

In *funebris* an average of 24.5 teeth was found on the dentary (six specimens), with a range of 21 to 27. This is contrasted to an average of 28 in *moringa* (seven specimens), with a range of 21 to 34. The average number of teeth exhibited on the maxillary in *funebris* was 17.3 (15 to 20), while *moringa* showed an average of 19.1 (14 to 22). These averages are only significant in that they show a slight tendency toward a greater number of teeth in *moringa*, but are not valid as an absolute differentiating characteristic.

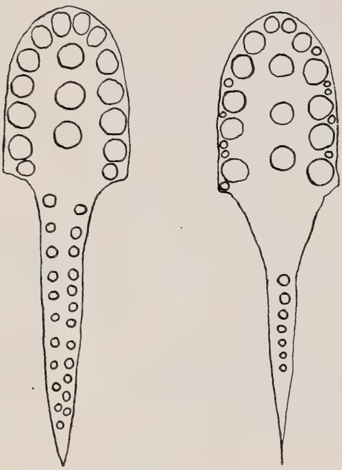

Figure 1. Distribution of the premaxillary - ethmo - vomerine teeth. Left: *G. funebris;* right: *G. moringa* (not same scale).

The distribution of teeth on the shaft of the premaxillary-ethmo-vomer was found to be a definite contrasting characteristic between the species (Figure 1). In *funebris* there are two rows of teeth on the shaft as contrasted to a single row in *moringa*. The number of teeth is variable in individual specimens. The above characteristics were very obvious in all specimens examined. It was found that in some specimens of *funebris*, especially the larger ones, the two rows were definitely separated throughout their length. In other specimens one of the rows would unite with

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ABBREVIATIONS

as — alisphenoid
ar — articulation surface
aa — articulo-angulare
bo — basioccipital
de — dentary
ep — epiotic
eo — exoccipital
fo — foramen
fr — frontal
gr — groove
hm — hyomandibular
io — interopercle
ib — interorbital opening
mx — maxillary
na — nasal
op — opercle
or — orbitals
os — orbitosphenoid
ob — otic bulla
pp — palatopterygoid
ps — parasphenoid
pa — parietal
po — preopercle
pr — process
pt — pterotic
pv — premaxillary-ethmo-vomer
qu — quadrate
sp — sphenotic
su — subopercle
sb — suborbitals
so — supraoccipital

the other at a point approximately two-thirds the total distance from the most anterior point of origin. This characteristic distribution of teeth was found to be one of the most consistent and apparent differences between the species.

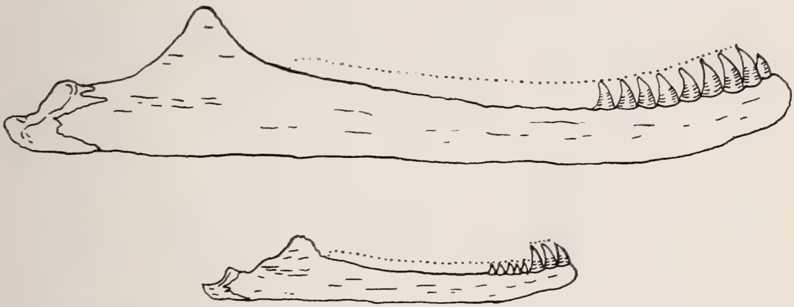

Figure 2. Decrease in size of teeth on dentary. Top: *G. funebris;* bottom: *G. moringa* (same scale).

The canine teeth on the anterior and lateral margins of the ventral surface of the premaxillary-ethmo-vomer proper also showed characteristics typical to each of the two species. These teeth were uniserial and approximately the same size in *funebris,* as contrasted to *moringa,* which exhibited smaller teeth, either in pairs or as single small teeth occurring in the spaces between the large canines (Figure 1). The latter arrangement was more apparent on the lateral margins of the ventral surface of the premaxillary-ethmo-vomer, and the pattern of the smaller teeth in the interspaces tended toward pairing, although some variation was evident. These pairs of small teeth are slightly displaced laterally with respect to the larger canines, and suggest a biserial arrangement. The canine teeth at the anterior end of the dentary, in *funebris,* tend to decrease in height gradually as they extend posteriorly (Figure 2). In *moringa,* however, the posterior teeth tend to be abruptly reduced in size. This tendency is not absolute, for some individual variation was encountered.

The presence of a distinct groove on the ventral medial surface of the maxillary bone of *funebris* is another differentiating character between the two species. The groove is definitely lacking in *moringa* (Figure 3). This feature was found to be very obvious and consistent in every specimen of *funebris* examined and was definitely lacking in all specimens of *moringa.*

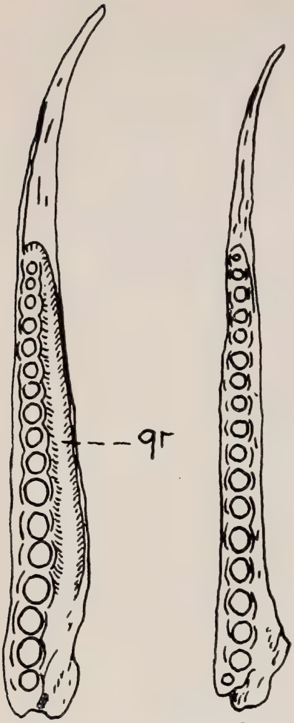

Figure 3. Maxillary bone. Left: *G. funebris;* right: *G. moringa.*

A raised process on the dorsal surface of the premaxillary-ethmo-vomer on the vertical from the anterior margin of the orbit is apparent in *funebris.* This process is much less pronounced or obsolete in *moringa.* Apparently this structure serves as a point of attachment for certain muscles (Figure 4). The suture line of the premaxillary-ethmo-vomer and the frontal on the dorsal surface of the cranium also shows a slight differentiation between the species. In *funebris* the suture tends to be somewhat irregular and "ragged" whereas in *moringa* it tends to be less "ragged" and more regular (Figure 5). There also seems to be a very slight variation in the general outline of this suture in the two species.

In comparing the length of the "snout" (measuring from the anterior margin of orbit to anterior tip of premaxillary-ethmo-vomer) to the length of the skull (measured from posterior-most projec-

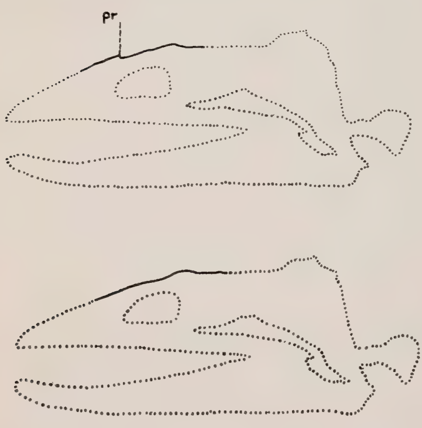

Figure 4. Lateral outline showing dorsal process of vomer. Top: *G. funebris;* bottom: *G. moringa.*

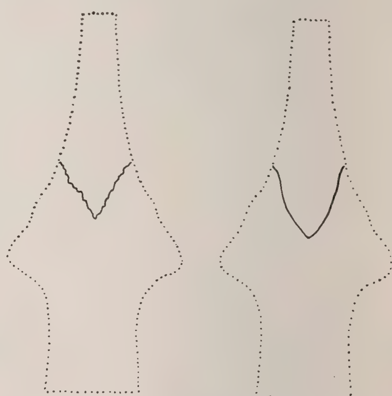

Figure 5. Outline of dorsal view of skulls showing premaxillary-ethmo-vomer and frontal suture. Left: *G. funebris;* right: *G. moringa.*

TABLE 1

	G. funebris						*G. moringa*						
Specimen	A	B	C	D	E	F	A	B	C	D	E	—	—
Skull length	83 *	69	93	84	112	88.8	60.8	64	58.9	64.5	52		
"Snout" length	23.2	19.8	26.9	24.5	34.0	28.1	19	20.1	19	21.7	19		
"Snout"/skull	27.9	28.7	28.9	29.2	30.4	31.6	31.2	31.4	32.2	33.6	36.6		
Specimen	F	D	A	C	E	—	B	C	F	G	D	E	A
de and aa length	80	118	99	97	117		65	65	71	66.9	72.3	72.1	55.5
hm and qu height	31	47.5	40.1	39.6	49		20.8	23	25.1	24.1	26.9	27	22
hm + qu/de + aa	38.8	40.2	40.5	40.8	41.8		32	35.4	35.4	36.1	37.2	37.5	39.7

Legend—Upper: Proportional relationship of length of "snout" to length of skull.
Lower: Proportional relationship of height of Hyomandibular (hm) and quadrate (qu) to length of dentary (de) and articulo-angulare (aa).

* All measurements in millimeters.

tion of the supraoccipital to the anterior tip of the premaxillary-ethmo-vomer) in the two species, certain differences were observed. *Funebris* showed a slightly shorter "snout" than *moringa* when the relationships were worked out in percentages of the "snout" to the total skull length (Table 1).

Another proportional difference was shown by the hyomandibular and the quadrate to the dentary and the articulo-angulare bones (Table 1). This was also worked out in percentages and shows the proportion of the height of the hyomandibular and the quadrate bones (measured from the dorsal-most point of hyomandibular on a vertical line to the ventral-most point of the quadrate) to the length of the lower jaw (measured from the most anterior point of the dentary bone to the most posterior point of the articulo-angulare). These trends show some variation, and cannot be considered as true differentiating characters.

Observations of Certain Anatomical Features Common to the Skulls of Both Species

In the Muraenidae, the opercular bones have become greatly reduced in size and it is evident that they must be less functional in this group than in the more typical teleosts (Figure 6). The opercle is the larger and apparently more functional of the group, while the other bones of this series (interopercle, subopercle, and preopercle) have all but lost their identities as such. The opercle articulates with the opercular process of the hyomandibular and is held in place by connective tissue. The bone is freely movable upon this process. The interopercle and subopercle lie immediately ventral to the opercle and are imbedded in the sheet of cartilage that also covers the opercle. The interopercle is slightly larger than the subopercle and both of the bones are very incompletely ossified. The preopercle lies in a small groove on the postero-lateral surface of the hyomandibular and quadrate bones. This bone is better ossified than the interopercle or the subopercle, and is rather elongate dorso-ventrally.

The X-ray photographs showed the very large muscle mass which is located dorsal and slight posterior to the cranium. This mass is evidently functional in opening and closing the powerful jaws of the moray. Of the two specimens radiographed, *funebris* showed a slightly greater development of this muscle group.

The posterior point of the maxillary bone is attached to the dorsal crest of the dentary by a sheet of connective tissue, presumably ligamentous in nature. The lower margin of the orbit is formed by the suborbitals which extend from the orbital process of the frontal to the dorsal anterior surface of the maxillary (Figure 6).

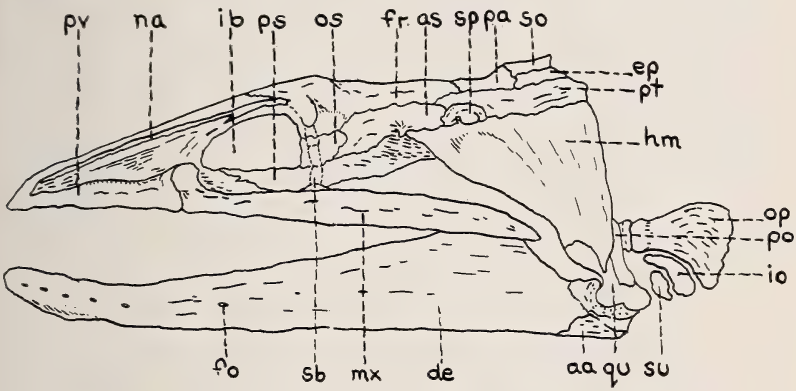

Figure 6. Lateral view of G. *moringa* skull.

At this point the great potential lateral expansion of the suspensorium should be emphasized. This is undoubtedly due to the following anatomical features:

1. The articulation of the hyomandibular with the cranium by means of cartilage.
2. The loose articulation of the quadrate and the articulo-angulare bones by means of cartilage and ligament.
3. The attachment of the posterior projection of the maxillary bone to the crest of the dentary by a flexible band of ligament.
4. The articulation of the anterior head of the maxillary with the maxillary process of the premaxillary-ethmo-vomer by cartilage and ligament.
5. The symphysis of the dentary bones consisting of cartilage.

The branchial appartus is definitely isolated posteriorly from the skull proper and the branchial cavity extends a considerable distance behind the head region. This is contrary to the usual teleostean condition in which the posterior boundary of the cavity, in the form of the pectoral arch, is suspended from the cranium

itself. Parr (1930) stated that as a result of this development, a greater portion of the gill cover of these eels has also become so far removed from the roots of its normal skeletal supports, in the form of the opercular and branchiostegal ossifications belonging to the general system of the visceral head skeleton, as to render these structures a very ineffective means of support even if they were extended backward over the entire cavity. Gregory (1932) believes that this was conditioned by the great development of the muscles that dilate the branchial chamber. He also inferred that the increased size of the respiratory muscles have apparently conditioned the powerful development of the hyomandibular and of the whole roof of the cranium; the latter has to resist the wrenching action of these muscles and affords a firm lodging for the brain, as well as a strong base for the heavily muscled jaws.

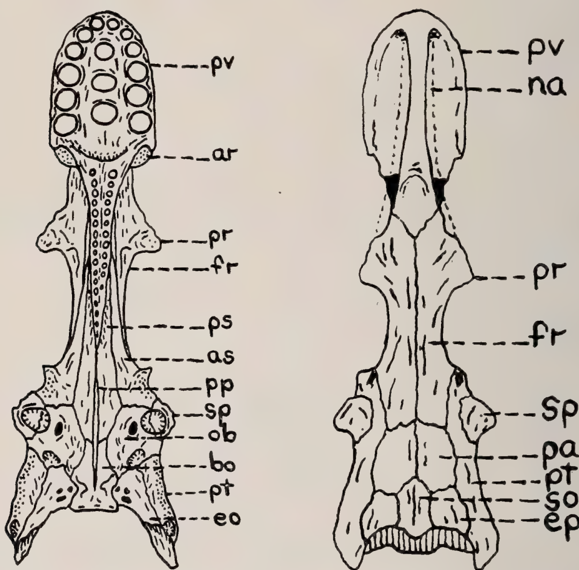

Figure 7. Left: Ventral view of *G. funebris* skull. Right: Dorsal view of same.

The branchiostegal rays were found to be quite numerous and long, and exhibited a tendency to curve upward and over the free margin of the opercular bones. This verifies the observations of Hubbs (1919). The fourth branchial arch in the Muraenidae has been modified, strengthened, and now supports the pharyngeal

arches of the branchial region. X-ray photographs show that the longer shaft of the pharyngeal arches lies ventral to the shorter.

In the *Gymnothorax* skull a great deviation from the typical teleostean type is observed (Figure 7). The skull has become more elongate, the bones more solid, and the jaws greatly lengthened. The first and second conditions are probably due to the fusion of certain bones, while the latter condition could be attributed not only to the lengthening of the jaw bones themselves, but also to the backward direction of the hyomandibular, thus lengthening the jaws posteriorly.

Much fusion of bones has apparently taken place in the skulls, resulting in a lesser number of bones retaining their identity when compared with bones of the typical teleostean skull. Loss of the ethmoid, the pterygoid, the premaxillary, and others by fusion and actual degeneration seems evident in the morays, and presumably, other members of the order. A most striking example of this change is the manner in which the posterior end of the palatopterygoid has been pulled out into the thin thread of bone which Regan (1912) reports as present in the Muraenidae (Figure 7, left).

Summary

A detailed comparative study of the skulls of the two species herein discussed reveal certain osteological differences. The following list includes those that seem more or less consistent:

1. Average number of teeth.
2. Distribution of teeth on the shaft of the premaxillary-ethmo-vomer.
3. Decrease in height of dentary teeth posteriorly.
4. Presence or absence of a maxillary groove.
5. Prominence of a process on the dorsal surface of the premaxillary-ethmo-vomer on a vertical from the anterior margin of the orbit.
6. Differences in the premaxillary-ethmo-vomer and frontal suture on the dorsal surface of the cranium.
7. Proportional differences in the length of the "snout" to the total skull length.
8. Proportional differences in the height of the hyomandibular and the articulo-angulare to the length of the dentary and quadrate bones.

In spite of the above differences, the fundamental anatomy of the skulls of *funebris* and *moringa* is almost identical. However, the skulls of the two species show a great deviation from the ancestral teleostean type, which appears to be the result of the degeneration and adaptation of certain structural features. Many of the bones have apparently undergone change through stress; others through decrease in function; and still others through the acquisition of new and different functions. This has resulted in fusion and strengthening taking place in the one extreme, and degeneracy and loss in the other. Probably the most obvious example of fusion and strengthening is the way in which the premaxillaries and ethmoid bones have become ankylosed to the vomer, which has resulted in greater strength and size to accommodate a change in function or functions. An example of the other extreme is the progressive degeneration of the opercular bones, which is undoubtedly the result of functional limitations.

The branchial apparatus in this group of fishes has apparently become more and more isolated from the skull proper, and also shows considerable deviation, both in structure and function, from the more typical teleostean type.

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THE COASTAL CLIMATES OF LOWER PENINSULAR FLORIDA

Wm. H. Pierson
University of Florida

Much is heard about alleged climatic differences between Florida's lower east coast and lower west coast. This paper attempts to describe the coastal climates of south Florida southward from the latitude of Tarpon Springs and Melbourne for the purpose of comparing and contrasting each coast with a view to ascertaining whether one coast is more favored than the other for human comfort.

The temperature data utilized is restricted to the recently made compilations by the United States Weather Bureau for the most recent period of sufficient length to give valid normals.[1] These compilations were prepared because normals based upon long term data are not strictly comparable with normals based upon conditions in recent years. The discrepancies, which often range from about one-half a degree to a degree or more, result from the progressive warming up of our climate.

When considering temperature conditions, special attention is given to the summer and winter seasons, as we can assume that the intermediate seasons, which are neither very hot nor very cold, are pleasantly comfortable to most persons.

Both coasts have hot summers. All but one station on both coasts have means during each of the four hot months—June, July, August and September—of 80°F, or above. August is everywhere the hottest month with means ranging from 81.5° at Melbourne to 83.2° at St. Petersburg. When the monthly means are combined to give the average summer temperature for each station, it is found that along the East Coast temperatures range from 80.5° at Melbourne to 82.2° at Miami Beach, the hottest station. As little as one degree in average temperature is significant when temperature is near the critical upper level of comfort. Average summer temperatures increase southward from 80.5° at Melbourne to 82.0° at Stuart, and then decline to 81.3° at Fort Lauderdale

[1] All data used in this study were furnished by the Florida Climatological Section Center at Jacksonville, Florida.

before rising to 82.2° at Miami Beach. The City of Miami, with a seasonal average of 81.2°, is a whole degree cooler than nearby Miami Beach, and is typical of the East Coast as a whole. On the West Coast, the northmost station, Tarpon Springs, has a seasonal average of 81.0° and the southernmost station, Everglades, has an average of 82.0°. All other stations have seasonal average temperatures between 81.0° and 82.0°, except St. Petersburg which is the warmest station with an average of 82.3°.

When the average summer temperatures are computed for each coast as a unit, the East Coast as a whole is found to average 81.4° and the West Coast 81.6°. The difference of 0.2° is obviously unimportant.

Average daily maximum and minimum temperatures, which tell us how much heat we can expect to endure during midday hours and how cool our nights will be for sleeping, are much better indicators of human comfort than monthly means. August has the highest average daily maxima on both coasts and July the second highest. On the East Coast, September maxima exceed those of June from West Palm Beach southward, but on the West Coast September is warmer than June only at the southernmost station, Everglades.

The monthly averages of the daily maxima for the four hot months were combined as an aid to comparison. On the East Coast, the seasonal average of daily maxima thus obtained is 88.3° at Melbourne, from whence it rises southward to 90.5° at Stuart. It then decreases toward the Miami area, where Miami Beach has an average maxima of 87.2° and Miami of only 86.4°. Miami, the southernmost station on the East Coast, has the coolest midday temperatures on either coast, whereas Everglades, its latitudinal counterpart on the West Coast, has the hottest midday temperatures. All West Coast stations have seasonal average daily maxima within the narrow range of 89.2° and 91.2°.

When the seasonal average of the daily maxima for each station are combined for each coast as a unit, we find that on the West Coast the daily maxima average 90.1°, while those of the East Coast average 88.5°. This differential of 1.6° is significant to comfort at these high temperatures. However, when the two relatively cool southernmost stations of Miami Beach and Miami are excluded, the East Coast from Fort Lauderdale northward averages 89.3°, which is only 0.8° cooler than the West Coast average. This small

difference in the season average of highest daily temperatures has some significance.

The thermometer does not tell the whole story of how hot the weather feels because relative humidity and air movement markedly affect the body's reaction or the "sensible temperature". Data on relative humidity taken at 1:30 P.M., near to the hours of highest temperature, are available for only three stations on each coast. The West Coast stations all have seasonal averages of midday relative humidity between 61% and 62%; while on the East Coast Melbourne averages 67.5%, West Palm Beach 64.2% and Miami 63.5%. The warmer part of the East Coast, from West Palm Beach northward, which has a seasonal average of the daily maxima 0.8° cooler than the West Coast, has a seasonal average of midday relative humidity some four or more percentage points higher. No satisfactory formula for computing "sensible temperature" is available, but it is believed that the difference in relative humidity in favor of the West Coast stations approximately offsets their higher daily maxima.

The third factor affecting sensible temperature is air movement. West Palm Beach has a summer season average hourly wind velocity of 7.4 mph, while its latitudinal counterpart, Fort Myers, has 7.3 mph. No data exists for East Coast stations north of West Palm Beach, hence no comparison can be made with the 7.4 mph average for Tampa and the 6.9 mph average for St. Petersburg. It can be pointed out that the Miami area is fortunate in having an optimum air movement of 11.0 mph during the four hot months. With the lowest daily maximum temperature, somewhat lower relative humidity and the strongest breezes, the Miami area has the most comfortable daytime temperature conditions on the East Coast, and very probably on both coasts.

Nights are rather warm on both coasts, with the average daily minima in the low 70s generally. Daily minimum temperatures for the hot season average 74.2° on the East Coast and 73.4° on the West Coast, an advantage of 0.8° for the West Coast. That part of the East Coast from Melbourne down to Ft. Lauderdale has a season average of 73.2°, which is almost identical with that for the West Coast as a whole, but the Miami area has very warm nights. The daily minima average 77.2° at Miami Beach and 76.1° at Miami. These high nighttime temperatures are offset in part by the rapidity of air movement.

After weighing the facts of actual temperature, relative humidity and air movement for both midday and nighttime hours, we must conclude that both coasts are about equally favored for human comfort during the summer season. Strictly local factors, such as good exposure to the prevailing winds, grassy or wooded surroundings and well ventilated housing are more important for comfort than is the choice of coasts.

Summer temperatures were found to vary but little with latitude or from one coast to the other, but winter temperatures vary quite markedly with latitude and to a significant degree from one coast to the other.

Both coasts have, of course, very mild winters. January is the coldest month at all stations except Fort Lauderdale, where February is slightly colder. On the West Coast the January means rise southward from 60.5° at Tarpon Springs to 67.2° at Everglades, while on the East Coast the coldest month means rise from 62.6° at Melbourne to 70.0° at Miami Beach and 68.5° at Miami. The isotherm of 64.4°F. mean temperature for the coldest month, which is quite generally used by climatologists as the line of demarcation between subtropical and tropical climates, crosses the East Coast between Melbourne and Vero Beach, thus designating nearly the whole of the East Coast as tropical. This isotherm crosses the West Coast at Punta Gorda, thus including only the south half of the coast within the tropics. St. Petersburg, which is nearly surrounded by water, has, however, a coldest month mean only slightly below the tropical level.

When the monthly averages of the three winter months are combined to give seasonal averages for each station and for each coast as a unit, we find the East Coast as a whole to be 3.2° warmer than the West Coast. Each East Coast station is warmer than its latitudinal counterpart on the West Coast, but the differential diminishes below the latitude of Punta Gorda. Melbourne, with a seasonal average of 63.6°, is 2.4° warmer than Tarpon Springs; West Palm Beach, with 67.8°, is 2.9° degrees warmer than Punta Gorda, and Miami, with 68.9°, is 1.2° warmer than Everglades.

Because both coasts have average winter temperatures sufficiently high to be very attractive to persons who desire to live or visit where winters are warm, it is the minimum temperatures that are of most significance to human comfort. In the north, the January

mean minimum temperature for Melbourne is 53.4° and that for Tampa 52.1°; while in the far south the January mean minimum for Miami is 62.6° and for Everglades 55.4°. Thus the East Coast is only 1.3° warmer at its upper end, but is 7.2° warmer in the far south, while insular Miami Beach is 10.1° warmer with a January mean minimum of 64.4°.

Although tropical or very nearly so in its lower portion, no part of mainland Florida is entirely frostless. Of the stations examined only Miami Beach has recorded no freezing weather within the most recent thirty year period. The frequency and severity of the occasional cold spells are significant in the evalution of climates for human comfort. As mapped by the Federal-State Frost Warning Service, the far south portions of both coasts, below the latitude of Fort Myers and West Palm Beach, experienced fewer than ten freezes between 1937 and 1952. The Frost Warning Service maps show that the frequency of occurrences of freezing weather at both low ground and high ground locations increases much more rapidly from Fort Myers northward along the West Coast than from West Palm Beach northward. The severity and duration of the cold spells can be seen from the maps to follow a similar pattern.

We may conclude that the East Coast is appreciably warmer in winter. Latitude for latitude, the East Coast experiences fewer spells of freezing weather, and they are usually less severe and of shorter duration.

Both coasts receive about the same aggregate total of rainfall. All West Coast stations receive between 50 and 54 inches annually. The distribution of rainfall is less uniform along the East Coast, ranging from only 43 inches at Miami Beach to 62 inches in the Fort Lauderdale-West Palm Beach area, and decreasing to about 50 inches in the far north. Each coast has a well defined rainy season in the summer and early autumn during which more than 60% of the annual total is received. The rainy period, which begins in June on both coasts, extends through September on the West Coast and through October on the East Coast. Rainfall is not excessively heavy in the rainy season on either coast as no station on either coast receives more than 10 inches in any month. On both coasts rain falls in measurable amounts on about half of the days during the rainy season. Except during the passage

of the occasional hurricanes, prolonged rainfall is rare, the summer rainfall being almost entirely convectional and of brief duration.

The late autumn, winter and spring months are moderately dry on both coasts. On the East Coast all stations receive less than 3 inches of rainfall per month during November to March, inclusive, with the exception of West Palm Beach. The driest period is the three winter months, during which the driest month varies from station to station being most often December or February. Most stations receive less than 2 inches during their driest month. The three winter months average between 1.9 inches and 2.3 inches per month at all stations. Miami and Miami Beach are the driest stations.

On the West Coast similar conditions prevail during the autumn, winter and spring. All stations receive less than 3 inches per month from November to April, inclusive. The driest month is November or December except in the Clearwater-Tarpon Springs area where it is April. Only one of the West Coast stations receives as much as 2 inches during its driest month. During the three winter months the West Coast stations from Punta Gorda northward receive slightly more rainfall than their latitudinal counterparts on the East Coast, having monthly overages between 2.7 inches and 2.0 inches, but the far south is quite dry. Everglades receives only 1.3 inches per month during the winter months.

Data on average cloud cover and on the percentage of the possible sunshine are sketchy. Tampa receives an average of 64% of the possible sunshine during the three winter months and it can be deduced from the data on cloudiness that Melbourne receives the same amount. St. Petersburg, which receives an average of 71% of the possible sunshine during the winter months, is the sunnist place for which data on sunshine are available. Miami receives a very amply average winter sunshine of 67%, but it is inferred from the data on cloudiness that Fort Myers and the south portion of the West Coast are even sunnier.

During the long, humid summers both coasts are about equally favored, or disfavored, for human comfort, according to your liking for heat. Both coasts are about equally favored as regards summer rainfall, although the East Coast is less favored in one section than the West Coast and more favored in another section. Both coasts are so dry during the autumn, winter and spring that the

minor differences in rainfall are of little consequence. Likewise, both coasts are so free from excessive cloudiness and so richly endowed with Florida sunshine that the minor differences that exist from place to place are of little significance. Latitude for latitude, the East Coast is distinctly warmer in winter, and in this respect it excels in human comfort according to the preferences of many people.

SYMBOLISM IN THE TREATMENT OF PROJECTIVES AND SIMILAR MATHEMATICAL PROCEDURES

Howard D. Allen
Tampa, Florida

Symbolism. In the addition and subtraction of entire equations, it seems wise to simplify the processes by means of special symbols. In order not to increase typographical problems and at the same time to avoid duplication of standard mathematical symbols, the use of inverted upper and lower case letters is made. The equation for ordinary (three dimensional) space (Allen, 1954),

$$U^2 = O \qquad \text{(I)},$$

may be thus represented by the inverted upper case letter ɑ .

The equation for the xy-plane,

$$U^2 = Z^2 = O \qquad \text{(II)},$$

is symbolized by the inverted upper case letter ɡ , while that of the x-axis,

$$U^2 = Z^2 = Y^2 = O \qquad \text{(III)},$$

is symbolized by the inverted capital ∀ .

Inequalities. The inequality of the line sector,

$$X^2 < R^2 \qquad \text{(IV)},$$

is symbolized by the inverted lower case ɟ , that of the disc,

$$X^2 + Y^2 < R^2 \qquad \text{(V)},$$

by the inverted lower case ʞ and that of the solid sphere,

$$X^2 + Y^2 + Z^2 < R^2 \qquad \text{(VI)},$$

by the inverted lower case letter ʌ .

Continua. The symbol for the origin,

$$X^2 = Y^2 = Z^2 = U^2 = O \qquad \text{(VII)},$$

is the inverted lower case ᴉ and that for the isolated points,

$$X^2 = R^2 \ , \ Y^2 = Z^2 = U^2 = O \qquad \text{(VIII)},$$

the inverted lower case ɟ . The inverted lower case ɐ is taken as the symbol for the circle,

$$X^2 + Y^2 = R^2 \qquad \text{(IX)},$$

the inverted lower ɔ as the symbol for the quadric surface,

$$X^2 + Y^2 + Z^2 = R^2 \qquad \text{(X)},$$

and the inverted lower case letter ə as the symbol for the space-u continuum.

To indicate the steps in mathematical induction (Brink, 1937) the capital letters Λ and Ǝ and the lower case letter ɥ symbolize respectively the steps of verification, extension and conclusion when preceding the proper related equation.

Intercepts. To illustrate the process of proof by mathematical induction the following equations are set up:

(Λ) ɐ — ∀ = ɟ (XI)

(Ǝ) ɔ — ꓭ = ɐ (XII)

(ɥ) ə — ᗡ = ɔ (XIII)

Projectives. Adding the inequality ɾ to either side of (XI) and placing the quantity, —∀ + ɾ, in parentheses the result is the projective (symbol ꓶ),

ꓶ ɐ — (∀ — ɾ) = ɟ + ɾ (XIV).

Since the resulting figure is confined to a single coordinate, the x-axis, it is termed a projective of the first order. A projective of the second order is

ꓶ ɔ — (ꓭ — ʞ) = ɐ + ʞ (XV).

We can verify by inspection that projectives of the first and second orders are true. Applying the same steps of mathematical induction that we applied to the intercepts alone it is concluded that corresponding projectives of the third order, etc., also are true, e.g.,

ɥ ꓶ ə — (ᗡ — ʎ) = ɔ + ʎ (XVI).

In (XV) the inequality representing that portion of the xy-plane within the intercept of the quadric surface (X) is first subtracted

from the xy-plane and the remainder of that plane then subtracted from the continuum, leaving only the intercept and all possible space within. This is simply the projection of the quadric surface on the diametrical (XY-plane), hence the name projective.

Conclusion. It should be noted that the appearance of a negative sign in front of a symbol for an inequality does not indicate that the sense of the inequality should be reversed as would be the case if one changed the sign of each side. The negative sign preceding the inequality symbols in (XIV), (XV), and (XVI) merely indicates that the given inequality is subtracted from the preceding equation (the presence of inequalities and the avoidance of negative space are characteristic of projectives).

By reversing the sense of ʎ it becomes the same as the quantity (ɑ — ʎ — ɔ) .

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SUPPLEMENTAL NOTE ON *DOLDINA LIMERA* (HEMIPTERA: REDUVIIDAE)

ROLAND F. HUSSEY[1] and JOE C. ELKINS[2]

In copying the final manuscript of our review[3] of the genus *Doldina* for the printer, an extensive portion was inadvertently omitted from the description of the new species *Doldina limera*, and the omission was not noticed until the article had appeared in print. The corrected description is given below; and we also note another correction to be made in our "Review," where, at line 3 of page 273, "Fig. 2" should read "Fig. 3".

Doldina limera Hussey and Elkins

Doldina limera Hussey and Elkins, 1956, Quart. Jour. Fla. Acad. Sci., 1955, 18(4): 267 [State of Pernambuco, Brasil; type in U. S. National Museum].

Length, ♂, 15.8 mm., humeral width 2.1 mm.

Pale testaceous; membrane hyaline, with numerous rather large fuscous spots inside closed cells and some faint brownish markings outside them; hind femora lightly spotted with brown; connexival segments, above and below, with a small piceous spot in outer apical angle, spots of last two segments becoming linear; abdominal dorsum with a broad brown median stripe, interrupted at most segmental incisures, with irregular longitudinal lines of black and red each side of median stripe, and with a submarginal row of large, round, brownish spots, one at middle and one at hind margin of each segment. Male genital segment with a few blackish spots.

Head, including neck, slightly longer than pronotum (257:246),[4] and more than twice as long to tip of tylus as its transocular width (257:123); pre-ocular margin to tip of antenniferous tubercle, as seen from above, two-thirds as long as as an eye (41:61) and less than half as long (41:96) as post-ocular margin measured to constriction forming the neck; minimum dorsal interocular distance about twice the width of an eye (61:32). Supra-antennal spines minute, almost obsolete. Lengths of antennal segments I:II = 765:563 (others

[1] Biology Department, University of Florida, Gainesville, Florida.
[2] American Optical Company, Instrument Division, Atlanta, Georgia.
[3] Quart. Jour. Fla. Acad. Sci., 1955, 18(4): 261-278 (1956).
[4] As in the original description, measurements in parentheses are in hundredths of a millimeter.

missing), first segment nearly one-fifth longer (765:650) than head, pronotum, and scutellum conjoined; pilosity of first segment quite short and sparse, hairs rarely longer than thickness of segment and commonly only slightly longer than the distance between their bases; pilosity on sides of head scanty, oblique, not projecting laterally beyond outer margins of eyes; gula with only a few long hairs.

Pronotum one-fifth longer on median line than its transhumeral width (246:209), posterior lobe nearly three-fifths longer (152:96) than anterior lobe, width at anterior angles about two-fifths (87:209) the transhumeral width. Posterior margin transverse before scutellum, posterior angles obtusely rounded, not at all produced backward as lobules, postero-lateral margins not sinuate; supra-humeral spines minute (0.07 mm. long), discal spines represented by minute black conical tubercles. Scutellum much longer than wide (140:96), its Y-shaped tumid area triangularly impressed at about mid-length of scutellum. Outer apical angle of first connexival segment with a small, blunt-tipped, digitiform spinule, second segment with only a small callose node, both of these piceous-brown. Median posterior process of hypopygial margin (Fig. 2) horizontal, directed forward, spatulate, a little broader at middle than at base, very plainly grooved on upper surface, extreme tip reflexed. Internal genitalia not dissected.

EXPLORATORY BEHAVIOR OF STOCK AND INBRED ALBINO RATS

Carl D. Williams
University of Miami

Qualitative observations of highly inbred rats and ordinary stock rats suggested that the inbred rats were markedly more timid than the stock rats. Similar qualitative observations concerning differences in behavior of stock rats and rats of the Wistar strain during maze learning were reported by Yerkes (1916).

Since exploratory behavior might be influenced by characteristics such as timidity, the present experiment was designed to provide quantitative comparisons of the exploratory behavior of highly inbred rats and ordinary stock rats.

Method

Forty male albino rats, 88 to 129 days old, were used. The 20 stock rats came from the colony maintained by the Department of Psychology of the University of Miami. The 20 inbred rats were of the 52nd generation of brother-sister matings and came from the Cancer Research Laboratory of the University of Miami. The rats were received from the Cancer Research Laboratory about a week before the investigation began.

The apparatus consisted of an enclosed, symmetrical Y maze. The floor and sides were wood and the top was hardware cloth. Each of the three arms consisted of two units of equal length; two arms were 24-in. long while the third arm was 20-in. long; each arm was 4⅜-in. wide, and 5½-in. high. Both units of one arm were white; a second arm had a white inner unit and an outer unit that was white with two black stripes 2-in. wide extending across the floor and up the walls; both units of the third arm were white. Thirteen small black objects, such as a beaded chain, a toy dog, a typewriter ribbon can, were fastened along the floor and sides of the outer 12 in. of the third arm. This arm was shortened to compensate for the surface area of the objects in the arm. The surface area available for exploration was thus the same in each arm. The area of the two black stripes in the second arm was equal to the surface area of the black objects in the third arm.

The maze was centered in a 6-ft. square enclosure made by black curtains. The animals were observed through a hole in the curtains. The usual precautions for eliminating any differential effect of extramaze cues were employed. Food and water were always present in the home cages and were never present in the maze.

Each rat was free to explore the Y maze for 10 min. on each of four days. Three days separated the second and third explorations. The number of units entered with all four feet was used as the measure of exploratory behavior.

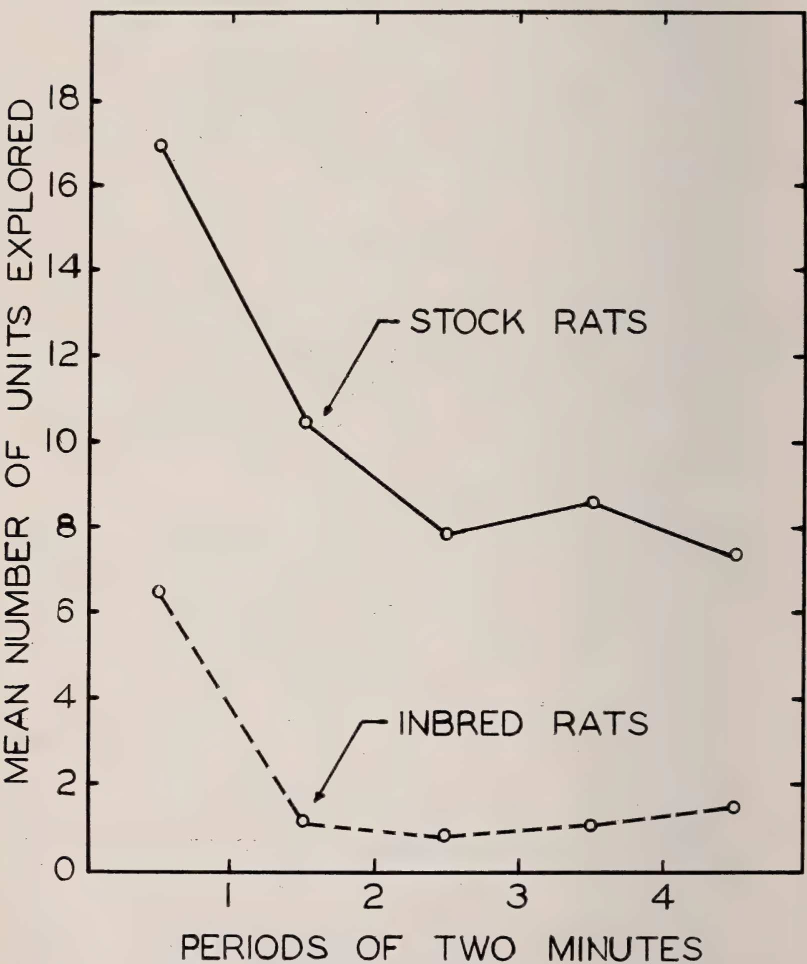

Fig. 1. Average amount of exploratory behavior as a function of time.

TABLE 1

Summary of Data for All Four Days Combined.*

	Stock Rats	Inbred Rats
Mean number of units entered	204.8	44.6
Percentage choice of three consecutive unlike arms	52.2%	43.8%
Percentage exploration of object arm	37.8%	49.5%
Percentage exploration of black-white arm	32.2%	29.8%
Percentage exploration of white arm	30.0%	20.7%

* All of the differences between the two groups are significant beyond the .01 level of confidence except for the % exploration of BW arm which is not significant.

Results and Discussion

The major results are presented in Figure 1 and Table 1. In Figure 1, the average amount of exploratory behavior for all four days combined is plotted as a function of time in the maze. The similarity of the curves seems noteworthy. These curves are similar to the negatively accelerated curves typically found in this type of situation as shown by Montgomery (1955).

Table 1 presents for all four days combined a summary of three types of data: first, the average number of units entered; second, the percentage of times that three different arms were entered in succession, an indication of the orderliness or systematic nature of the exploratory behavior of rats in simple mazes; and third, the percentages of entry into units of each arm. In brief, the results summarized in Table 1 show that, as compared to the stock rats, the inbred rats (a) explored markedly less, (b) were less orderly in exploring the maze, (c) showed greater preference for the object arm and greater aversion for the white arm.

The quantitative results of this experiment confirm and extend the qualitative observations previously made by Yerkes (1916). They are consistent with numerous reports of behavioral characteristics and genetic determinants such as those of Lindzey (1951) and Stamm (1954). The present results seem especially related to Brody's report (1950) that inbreeding is frequently accompanied by a decrease in vigor, vitality, and fertility. It should be pointed out that the present results may not conclusively be ascribed to genetic factors, since the animals were raised in different laboratories. Further work in which environmental factors are more nearly equated is in progress.

Summary

The exploratory behavior of highly inbred albino rats was compared with that of stock albino rats in a simple Y maze.

The two groups explored the maze in relation to time of exposure in a similar fashion. They differed significantly in three other dimensions of exploratory behavior.

Acknowledgments

I wish to thank Dr. Wilhelmina F. Dunning, Director of the Cancer Research Laboratory, for providing the inbred rats; and Miss Leona Lehman for assisting in the analysis of the data.

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FRESHWATER MOLLUSKS FROM THE MAGNETAWAN RIVER AND POVERTY BAY IN THE PROVINCE OF ONTARIO, CANADA [1]

Robert M. DeWitt
University of Florida

This paper is based upon a collection of freshwater mollusks made during the summer of 1955 from the Magnetawan River and adjacent Poverty Bay. The relatively small area collected is located in the township of Croft, district of Parry Sound in the province of Ontario. The river drains into Georgian Bay, a portion of Lake Huron. Low water made many of the normally deep areas of the river accessible to collecting and a long series of specimens were taken. The waters in this region are extremely soft and deeply stained with humic materials. Poverty Bay is a back-water of the river and communicates with it through a narrow, shallow channel. Considerable quantities of aquatic vegetation are present in both areas and include the genera *Potomogeton, Vallisneria, Utricularia, Nuphar, Nymphaea, Sagittaria, Scirpus* and *Typha, Fontinalis* is abundant in the river.

The mollusk fauna is a depauperate one. Five species of pelecypods and seven species of gastropods were taken. The shell of the older naiads are extremely eroded in the umbonal regions; in some cases holes were worn through the shell at the attachment of the adductor muscle. Beak sculpture was present only in very young individuals. The naiads were checked for gravidness and for parasitism by watermites. The mites collected will be identified and reported on at a later date. The severity of infection by larval trematodes was judged by the extent to which the nacre of the shell was stained and blistered.

Pelecypods

Elliptio complanatus Dillwyn.

This was the most common and abundant of the naiads. It appeared to have no ecological preference although the largest specimens were obtained from the river. No gravid individuals

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[1] A contribution from the Department of Biology, University of Florida.

were collected in June, July or August. Approximately 600 specimens were examined and none were found to be infected with mites. The nacre was not stained and blistered to the extent observed in the other genera of naiads which indicates a less severe infection by larval trematodes. The largest individual collected from the river measured 112 mm long, 61 mm in height and 36 mm in thickness. The largest specimen from the bay measured 69 mm long, 35 mm high and 20 mm in thickness. Conditions in the river appear to be more favorable for growth.

Lasmigona costata Rafinesque.

This was the least abundant of the naiads collected; only four living specimens were taken. It is confined to the river and is found only in pockets of deep water where the bottom is composed of gravel and sand and a considerable current is present. The individuals collected in July and August were not gravid. One individual harbored one pair of mites (*Unionicola* sp.). The nacre was heavily stained and blistered in two individuals. The largest specimen measured 114 mm in length, 66 mm in height and was 39 mm thick.

Anodonta grandis Say.

This species was much more abundant in the river than in the bay. They were taken from a substrate of mud, sand or gravel in water one to five feet deep. The shells were extremely thin which is characteristic of these forms in northern waters. Individuals collected during July and August were gravid. Watermites, both *Unionicola* sp. and *Najadicola* sp. were found in *A. grandis.* In all specimens taken, the nacre was deeply stained a reddish color and was badly blistered in many cases. The largest specimen collected from the river measured 103 mm long, 50 mm in height and was 35 mm thick; the largest from the bay was 77 mm long, 43 mm high and 30 mm in thickness. This indicates again that existing river conditions favor greater growth.

Lampsilis siliquoidea Barnes.

This form was collected only in the river from a substrate of sand and gravel where there was a considerable current of water. No specimens were found in back-waters. This distribution varies from that of Baker (1928) and van der Schalie (1938) who report it in greater abundance in quieter waters. Its absence in the bay

is not due to absence of its natural hosts (yellow perch and walleyed pike) which are found in both localities. Gravid females were taken during the months of July and August. No mites were found in *L. siliquoidea.* Specimens examined were comparatively free of trematode infection; only a few individuals showed a light staining of the nacre and there were none in which the nacre was blistered. The largest male was 100 mm long, 53 mm high and 38 mm thick. The largest female measured 83 mm in length, 49 mm in height and 34 mm in thickness.

Sphaerium striatinum Lamarck.

This small clam was extremely abundant in the river but absent from the bay. It was taken in shallow riffles where the bottom was covered with coarse gravel. Embryos were present within the majority of specimens examined.

Gastropoda

Campeloma decisum Say.

No living specimens of this snail were taken. Dead shells were obtained from sandy areas in the river and in all cases the spire was badly eroded. The apparent scarcity of this species may be due to the relatively few sandy areas that occur in the river which will support a population of this snail.

Amnicola limosa Say.

This species was extremely abundant both in the river and in the bay. It was found on submerged aquatic vegetation and was also taken from the underside of *Nymphaea* and *Nuphar* leaves. Eggs were observed during the months of July and August.

Lymnaea columella Say.

Next to *Physa heterostropha,* this was the most abundant pulmonate in the waters of this region. It was common both in the river and in the bay where large numbers were found on both the upper and lower surfaces of the pads of water lilies. Egg masses were taken during July and August.

Helisoma anceps Menke.

This species occurs in the river and the bay. Mature specimens were rare but a number of half-grown individuals were taken from

submerged aquatic vegetation and the undersurfaces of water lily pads. No egg masses were found during July and August.

Helisoma campanulatum Say.

One, freshly dead, mature specimen was found in the river.

Ferrissia parallela Haldeman.

This form occurred in both localities but was much more abundant where there was a slight flow of water. The greatest number of individuals were collected from the stems and pads of water lilies. Egg masses were found in July and August.

Physa heterostropha Say.

This snail was very abundant in the river in shallow water on the surface of rocks covered with an algal growth. It was rare in the bay; occasionally a living specimen was taken. Most of the individuals were immature and only an occasional egg mass was found during July and August.

Acknowledgments

I am indebted to Dr. Henry van der Schalie for checking identifications of the naiads and to Mr. H. B. Herrington for identifying the specimens of *Sphaerium*. W. J. Greenwood aided in making the collections.

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ENCOPE MICHELINI FROM THE PAMLICO FORMATION OF VOLUSIA COUNTY, FLORIDA [1]

W. P. Leutze
The Ohio State University

Introduction

Two fragments of the echinoid *Encope michelini* Agassiz were collected by the writer in December 1954 from an exposure of the Pamlico formation (Pleistocene) in Volusia County, Florida. These specimens are presently on file with the Florida Geological Survey and have been numbered I-8227A and I-8227B.

The occurrence of *E. michelini* in the Pamlico formation was first reported by Berry (1941), who described specimens from this formation in South Carolina. *E. michelini* is found living today in the Gulf of Mexico, and is very common along some parts of the Gulf Coast of Florida. It has not been previously reported from the Pamlico formation of the State. Cooke (1942) reported fossils of the species from three localities in Florida. At two of Cooke's localities, Biscayne Bay and Big Pine Key, specimens were found in the Miami oolite (Pleistocene). The formation at the third site, "St. Lucie Canal, 1 mile from Lake Okeechobee, Palm Beach County," was identified as the Caloosahatchee marl, of Pliocene age (Cooke, 1942).

Locality

The echinoid fragments from Volusia County were obtained from an exposure on the north bank of Spruce Creek at a place known locally as "The High Bank." A dirt road leads to the locality, which is in the NW¼SW¼ sec. 28, T. 16 S., R. 33 E. It is approximately 4.1 miles S. 12° W. from the post office at Port Orange.

Geologic Horizon

At the locality described, Spruce Creek breaches the seaward edge of the Pamlico formation. The section exposed in the bank of the creek consists of 8 to 10 feet of barren, iron-stained quartz sand which was probably deposited by the wind during Silver

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[1] Publication authorized by the Director of the U. S. Geological Survey.

Bluff time (Pleistocene). This bed unconformably overlies 10 to 14 feet of sand and shelly sand beds of the Pamlico formation. The lowest bed of the Pamlico exposed is sandy clay, containing many shells of marine mollusks. This is the bed in which the echinoid fragments were found.

Description

The writer identified both fragments as pieces of *Encope michelini* Agassiz. The better specimen, I-8227A, consists of ambulacrum I and part of II, and interambulacrum 1 and half of 5. The test is composed of crystallized calcite, to which grains of shell and quartz sand are firmly cemented. The lunle is 14 mm. long, and although broken so that only one side is visible, it appears to have been narrow. The anterior notch is not as deep as the anterolateral one, but the fragmentary condition of the specimen prevented accurate measurement of these features. Tubercules are visible in several places on both the oral and the aboral surfaces. Ambulacral furrows are not distinguishable. The specimen is 13 mm. thick at the apex, and came from an animal having an original diameter of about 12 cm.

Specimen I-8227B is composed of ambulacrum V and part of IV, and most of interambulacrum 4 and half of 5. This specimen also is crystallized calcite, and is almost completely encrusted with sand. The only details not obscured by the fragmentary condition and encrustation are that the anterolateral notch is relatively deep —not less than 1.5 cm., and the lunle is 7 mm. long. From the latter, it is clear that fragments A and B came from different individuals. The thickness of B at the apex is 11 mm. The original diameter of the animal is difficult to estimate. It was probably of about the same size as the other.

Remarks

The fragments might be mistaken for *Mellita quinquiesperforata* (Leske), which they superficially resemble. *M. quinquiesperforata* is common along the Atlantic coast of Florida today. The internal structures of the two species are distinctive and provide an easy means of identification.

M. quinquiesperforata has internal pillars which join the oral and aboral surfaces of the test. From the margin to the ends of the

petals, these pillars are so closely spaced as to form an almost solid ring. Pairs of pillars on either side of each petal are located about half the distance from the oculogenital area to the internal margin of the outer ring of pillars.

The interior of *E. michelini* is nearly filled by a spongy-looking internal skeleton of calcium carbonate. Near the margin, this material is united into a nearly solid ring, as in *Mellita*. Apically, the internal skeleton is more porous. There are, in addition, three clearly defined hollow areas: (1), a small, stellate central cavity; (2), radial canals, located under each of the 10 poriferous areas; (3), the ring canal. Each of these spaces is lined with a smooth, perforated wall.

E. michelini must have had a considerably larger range during the Pleistocene epoch than it has today. Changes in geography may help to explain this fact. Cooke (1939) and MacNeil (1950) indicate that Orange Springs (Marion County) was near the southern extremity of the Florida peninsula during the Sangamon interglacial stage, when the sea stood as much as 100 feet higher than its present level. In Pamlico time, the sea level was about 25 to 30 feet higher than it is today, and the Florida peninsula extended only as far south as the north shore of Lake Okeechobee. Thus, it is apparent why Gulf and Atlantic faunas were less sharply defined during the Pleistocene than they are today. *E. michelini* is a useful index fossil along the Atlantic coast, where it seems to have died out at the close of the Pleistocene epoch.

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ATTEMPTED TUMOR INDUCTION IN GUINEA PIGS [1]

Andrew W. Breidenbach and Mary F. Argus
University of Florida

Tumors are known to occur spontaneously in rats. Similar tumors can also be induced in this species by administering a cancer producing compound — a process termed chemical carcinogenesis. Using this method, Morris *et al* (1950) showed that oral administration of 2-aminofluorene (AF) to rats results in the development of malignant growths. The metabolic fate of AF in the rat was studied by Gutmann, Kiely and Klein (1952). Similarly, Meade and Ray (1954) continued the study of the metabolic fate of AF in a second species, the guinea pig. A comparison of the data from these studies revealed differences in the fate of AF in the two animals. A discussion of the data in the latter paper (Meade and Ray, 1954) suggests a partial explanation for the susceptibility of the rat to chemical carcinogenesis. Conversely they also suggest reasons for the relative resistance of guinea pigs to spontaneous (Maury, 1931) and induced (Shimkin and Mider, 1941; Haagensen, 1936; Russell *et al,* 1952) neoplasms. However, to complete the comparison of the metabolism and carcinogenicity of AF in the rat and guinea pig it was desirable to test the carcinogenicity of AF in the guinea pig. Since ascorbic acid is an essential dietary factor for the guinea pig, but non-essential for the rat, the effect of mild ascorbic acid deficiency on the attempted carcinogenesis was studied concurrently.

Procedure

A total of 64 male Rockland Farms guinea pigs having an initial average weight of 370 g. were employed. The animals were divided into 4 equal groups and received food, water, ascorbic acid and AF as shown in Table I. All animals were autopsied at death or sacrificed. Suspicious tissue was excised, fixed, embedded, and sectioned for microscopic examination.

[1] A contribution from the Cancer Research Laboratory aided by a grant from the Damon Runyon Memorial Fund.

TABLE I

Group [1]	Basal Diet [2] (offered ad libitum)	Orally Administered [3] Ascorbic Acid (mg./100 g. body wt./week)
1	Water, PRCC [4]	17.0
2	Water, PRCC with 0.06% AF [5]	17.0
3	Water, PRCC	2.8
4	Water, PRCC with 0.06% AF	2.8

[1] Surviving animals sacrificed after 24 months.

[2] Diets and ascorbic acid regimen continued 20 months. Animals surviving 20 months were returned to stock diet of PRCC, water and greens.

[3] Administered in neutralized aqueous solution twice weekly.

[4] Purina Rabbit Chow Checkers, Purina Mills, St. Louis, Missouri. Preliminary analysis of samples representing our entire stock showed concentration of ascorbic acid to be less than 0.08 mg.%.

[5] 8118 g. PRCC mixed well with 1,500 ml. acetone containing 486 mg. AF (Organic Syntheses, 1944) and air dried 72 hours.

Results and Discussion

Two years after the initiation of the experiment the surviving animals were sacrified. A large number of those that died before this time exhibited the gross symptomatology of pneumonia and other lung infections. One animal in group 4 exhibited adenomatous areas in the lung. No tumors were found in any group. Grossly evident liver damage, such as is seen after administration of toxic substances was not noted.

TABLE II

Comparison of the Carcinogenicity of 2-Aminofluorene in Guinea Pig and Rat

	Oral Administration of AF				*Observed*	*Tumors*
Species	% in Diet	Estimated mg/Animal /Day	Length of Adm. (Days)	Estimated Total mg/ Animal	(Number of Days)	
G.P.	0.06	21	267*	5,600*	720*	0/12**
Rat†	0.05	3.3	161	537	284	9/11

* Maximum.

** Numerator represents total number of tumors; denominator, number of animals from Groups 2 and 4 surviving the feeding period.

† Data for rat based on those reported by Morris *et al* (1950).

A comparison of the carcinogenicity of AF in the rat and guinea pig is given in Table II. The data show conclusively that orally administered AF, while carcinogenic for the rat (Morris *et al,* 1950), is not for the guinea pig, although it was fed for a longer period. The guinea pig apparently enjoys a type of protective mechanism against carcinogenesis. Further study of this protective factor would seem advisable.

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RESEARCH NOTES

KNOWN GEOGRAPHIC RANGE OF *GYMNODINIUM BREVIS* DAVIS. —It is commonly asserted that Protista are cosmopolitan in distribution (within their ecologic range), and there are few fresh water or oceanic species which have not been found repeatedly and over a wide geographic range. Since Davis (1) described *Gymnodinium brevis* in 1948 and coincidentally it was incriminated as the cause of the destructive Florida west coast "Red Tide" (2) the organism has not been reported from any other location. The term "Red Tide" has come into very loose use, frequently being applied to any marine bloom (3), whether fish are killed or not. By connotation, *G. brevis* is sometimes blamed, with no actual record of its occurrence, whereas fish kills have been of frequent occurrence in many parts of the world, with little knowledge of a causative organism, if any.

Such a situation occurred in waters along the north coast of Trinidad in March, 1902, and early January, 1955, (Trinidad "Guardian" January 5, 1955). Subsequently, the Fisheries Officer for Trinidad, Mr. W. A. King-Webster, put up water samples from the area, in 5% formalin. In June the writer made a trip to Trinidad and sampled the area extensively, thru the courtesy of the U. S. Navy and the U. S. Public Health Service. The unkilled and killed June samples contained rather typical Caribbean inshore plankton algae and protozoa, including some 15 species of dinoflagellates but no *Gymnodinium brevis.*

The King-Webster samples were taken March 25, March 30 and April 1, 1955, at temperatures from 69°F. to 70.5°F. Samples 1 and 3 were taken at Lat. 10°50′N., 10°51′N, and Long. 61°13′W. respectively. Samples 2 and 4 were both taken at Lat. 10°51′N. and Long. 61°13′W., on March 30 and April 1. Samples 1 and 3 contained no *brevis* but in sample 2 there were 65 per ml., and in sample 4, one per ml.

This constitutes the first known extension of the range of *G. brevis* from the Florida west coast, and it is significant. According to commercial fishermen, there is a yearly fish kill about the first of the year, which is not always catastrophic, but might be due to *brevis.* So well known is this that it has become the basis of a study of areal ocean currents as affected by meteorology and the flow of the Orinoco River, emptying its nutrient rich waters into the Gulf of Paria. Finally, currents from this area might well prove the seeding mechanism for outbreaks along the Florida Gulf Coast. This in turn would affect the prediction as to when blooms might be expected, and would also affect possible preventive measures, copper sulfate or other.

These matters are under further scrutiny.

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—James B. Lackey, University of Florida, Gainesville

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THE QUARTERLY JOURNAL OF THE FLORIDA ACADEMY OF SCIENCES

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THE SCIENTIFIC ATTITUDE TOWARD EDUCATION

RAYMOND F. BELLAMY
Florida State University

The terms "science," "scientist," "scientific method" or even any term which designates a scientific organization such as an Academy of Science express differing and somewhat vague concepts. Science has been defined as a specific body of knowledge, as classified knowledge (Ogburn and Nimkoff: 1950) or, more exactingly yet, as organized knowledge (Ward: 1905). Others will have none of this; they maintain stoutly that science is a method and nothing but a method. Some even go so far as to limit the method to mathematical measurement, and they are therefore eventually forced to state that there can be no separate sciences.

Despite the varying concepts of science, and therefore of the scientist, there are some universally accepted earmarks of each. One of these, and probably the most outstanding, is that the scientist searches for proof, that he does not accept hearsay or unverified statements, and that, in consequence, he is not carried away by his own feelings and desires. The scientist first, last, and always searches for truth—verified, tested, and proven truth. Unlike Hitler, he does not "think with his blood."

This, in essence, is the positivistic method which was developed by Auguste Comte. Modern social science has found that some of the details of Comte's method are not applicable to its field, but the heart of it, which is merely that we must insist on proof, still remains, and it must remain for all branches of knowledge. This becomes difficult at times, since we want to accept something as true so badly that we are loath to search for possibly nonexistent proof.

This was well portrayed by Franklin H. Giddings (1901) who classified humanity into four groups, the "ideo-motor," the "ideo-

emotional," the "dogmatic-emotional," and the "critical-intellectual." The first two of these are low in the intellectual scale and need not concern us here, but the dogmatic-emotional group, sad to say, includes most of humanity, and there is not one of us but what gets into at least the fringe of it occasionally. This type of person "believes what he wants to believe because he wants to believe it." The more extreme persons of this type simply will not listen to any argument nor pay any attention to any evidence which is not in harmony with their views. Positive and unalterable attitudes will be taken on such questions as segregation or desegregation, political beliefs, religious doctrines, and educational practices.

In great contrast to these is the critical-intellectual, the one who hunts for the truth and will exhaust every source of evidence, regardless of how he feels about the matter. This attitude is so difficult to attain that we may think of it as an ideal or goal, a sort of "Excelsior" toward which we may strive but never quite reach. Rarely do we find anyone who attains this exalted nature. Charles Darwin qualified in the biological sciences. He never would publish anything until he had done his best to disprove it—quite in contrast to so many who strive mightily to establish some pet theory but ignore evidence against it.

The difficulty in avoiding the dogmatic-emotional type of behavior generally becomes greater as we reach advanced years. This is because so many things change from what we have known all our lives, and because they are different they seem undersirable, even terrible. Kluckhohn analyses and explains this clearly in his *Mirror for Man* (1949).

As Exhibit A, I may use my own experiences. Many times in the last few years, as I drew near the three score and ten mark, I have been confronted by new educational practices which seemed to be positively harmful. Some of them, I have never been able to accept, for example, the machine grading of examination papers; the most I have been able to accomplish has been to say, "I *may* be mistaken; others are quite as competent or more so than I to judge such matters, and it is probable that they are correct." In other instances, I have become completely converted; at first I was opposed to integrated or generalized courses, but with the passage of years I have become enthusiastic about them.

The situation is complicated by the fact, as Kluckhohn *(op. cit.)* points out, that not always are the newer practices or types of

action superior. There is always an element of experimenting about them, and sometimes they are mistakes. If we old fellows always were wrong, everything would be simple, but the fact that we are sometimes, even if rarely, correct makes for a lot of trouble.

A glance at the history of education shows us a fairly consistent pattern of change throughout the ages (Bellamy, 1942). Some practices which are more or less suitable for the time and conditions are adopted and become established. As time passes and conditions change, these practices are retained and defended strongly as semi-sacred, even long after they have lost their value. Moreover, with their loss of functional value, they become more and more crystallized, formalized, and in one word dead. It is only after long and stubborn resistance that they are given up for newer and more suitable methods and practices. Thus, since the beginning of the Christian era, our western education has gone through such stages as the catechismal or catechetical form, the ensuing classicism, rationalism, romanticism, realism of two or three different types, with later emphasis on mental and social factors. The change into each of these has been opposed bitterly by the established leaders, especially the older leaders.

It is still true that one of the greatest difficulties, especially for those of us who have reached an advanced age, is to see any value in changing educational practices. Since we have devoted our lives to certain ideals and philosophies, it is indeed hard, as we near the end, to see them swept from under our feet by the washing tides, even as old King Canute did, that we can not sweep back.

Outraged by the destruction of what we think of as our life work, and frustrated by our inability to do anything about it, we frequently turn bitter, vindictive, abusive. Under such a disturbed emotional condition, we are prone to make wild and unproven statements, accept as final truth the opinions of others which harmonize with our own, and magnify some molehill of evidence into a mountain—a veritable Everest—of unproven but universally applicable conclusions. Typical of such an attitude is that demonstrated in Flesch's *Why Johnny Can't Read* (1955) which the author himself describes as "an angry book."

Basic to our educational philosophies are certain tenets which we conceive as absolute, and it is difficult indeed to give them up. Personally, for many years, I thought it was hardly worth while

going to college unless one took a lot of Greek and Latin. As years went by and I associated with many scholars who had never had any training in the classics but who were quite evidently superior to myself, I was forced to change my mind. Others have put similar stress on different subjects. There are those who would exalt philosophy as the *sine qua non* and only subject of paramount value. History, even the old date-and-event type of history, has similarly been put on a pedestal and worshipped as the One and Only. Mathematics has also been singled out, and we find such extreme statements as "algebra . . . absolutely necessary for anyone who does analytical thinking" (Becknell, 1955). This last statement would rule out some of the greatest analytical thinkers of all time.

The lengths to which some of us will go on occasion are amazing. I knew an outstanding biologist who made statements about educational and social matters which were astounding in their extremity. It was no use to reason with him. I often wondered what he would have thought if the authorities in education and the social sciences had made such positive statements about the details of his subject. I wondered, too, what would have happened if some of his students had drawn conclusions with as little regard to sifted evidence.

Occasionally those in the field of technical education, especially the older ones, make statements which are as apocryphal as those made by anybody else. At a Parent-Teacher meeting I listened to a talk by an elderly lady who had given her life to elementary education. Among other things, she said that modern educators advocated allowing children to curse and swear, and that it was all right for a boy to dispute, disobey, and curse his father. I wondered where on earth she got that material. In fact, I challenged her to produce it, but she never did. I presume that she had read somewhere that it is not always wise to be too abrupt with a child, especially a maladjusted child.

It is always possible to collect evidence of what we want to prove if we resort to "card stacking." I could pick out a little army of my students over the last forty-three years who could do only a very poor job of reading and spelling. I could give some lurid examples, such as the college senior who could not divide by long division. Also, I have known quite a number of teachers who hardly could write a sentence; such poorly prepared teachers were rather common during World War II and the period im-

mediately following. Some one has said that in the attempt to find teachers at that time, they not only scraped the bottom of the barrel but turned the barrel over and took what was under it.

If there is something which we want to believe, we are prone to accept a few striking or startling examples as typical and as constituting generalized proof. This danger is always present, and many have been the pitfalls into which even the best of scientists have fallen. If we see a tall heavy woman married to a skinny little shrimp of a man we are apt to say, "Yes, that's always the way it is; opposites attract." Ward made this very error and raised it to a fundamental principle (1919). But Karl Pearson in his Galton Research Laboratory found that the exact opposite is true. It is quite a similar situation when we come in contact with a few especially stupid or uninterested students or even some outstanding weak schools. But if we should subject our conclusions to a rigid test, comparable to that of Pearson's, we would be acting more like reputable scientists.

A short time ago my attention was called to a vigorous attack on our present day education; assertions were made that "Our American system of free public education is today almost a total failure" (Becknell, 1955). It was also stated that our young people are woefully lacking in the ability to read, write, and express themselves in other ways. I became so interested that I decided to notice carefully how my students did in the way of using English on their examination papers. There were seventy-one of my students who answered discussion questions as part of the semester examination. They were written under pressure for time, and the students were undoubtedly under considerable emotional strain. The conditions were ideal for glaring mistakes in the language used, yet I was amazed at how few errors there were. There were a few misspelled words, chief of which was the use of "to" for "too", and occasionally a singular subject would be used with a plural, such as "Everyone knows what they would do." The most common mistake, and one which is excusable, was to say, "Statistics are". There was just one crude error in the seventy-one papers, and I suspect that that was due to haste.

Not only were these papers remarkably free from errors, but the sentence structure, the clarity of expression, and the literary quality were of high order. I have a suspicion that they were better than anything which I could have done while I was in

college, and some of them were probably better than what I could do now.

Educational practices have always been considered fair game by those who wished to attack them, and absence of information and understanding has been no deterrent. I well remember from the days of my youth one citizen and patron who spoke for the many when he said, "I ain't never taught school, that is, but I know how it ought to be done." President Elliot met stiff opposition and criticism when he "turned Harvard over with a pancake turner" as his action was described. The great jurist, Oliver Wendell Holmes, met similar criticism because he introduced something new in the teaching of law in Harvard (Bowen, 1944). Horace Mann received his share of villification. And so it goes and has gone. So well known has been this practice of belaboring anything new in education that even our pioneer poets described it, showing how the school trustees abused the young teacher for "leavin' the k off of musick" and committing other such heinous sins.

Thus, it is doubtful if our educational system today is under any more severe criticism that it has been almost continuously, but sometimes it appears to be, and many have stated that never before has the attack been so heavy. These attacks are made by different types of critics, and it appears that a least a goodly portion of them are deliberate attempts to undermine not only our schools but our national life as well. And, as so often happens, those who make this type of attack use the mechanism of accusing the schools themselves of leaning toward communism. At least some of the leaders in these attacks have records that would indicate Nazi or communist connections, but typically they do not take a leading part in the attack but utilize well meaning but somewhat gullible persons as cats' paws. Sometimes such volcanic eruptions occur that it is doubtful if we ever shall fully understand just what they really mean. The events of Pasadena (Hulbard, 1951) and of Englewood, New Jersey (Morse, 1951), are cases of this type.

Other attacks are made by well meaning and even scholarly persons, and often there is justification for much of their criticism, but when it is examined and analyzed carefully it is usually found that they do not have anything like a true picture of what they are discussing. A few illustrations will illustrate this type of attack.

Arthur Bestor (1953) makes a sincere attempt to evaluate our educational system, and his criticisms are not without merit. But his sources were not of the best, in fact, they appear to have been badly chosen. R. Will Burnett (1954) points out many fatal weaknesses in Bestor's treatment. Bestor would abolish schools of education entirely and shrink instruction in this field to a few courses only. However, my own study of Bestor's plan leads me to think that by the time he had it in operation it would be almost exactly what we have at the present time. He does not think so, but a careful perusal of what he calls for leads me to think that there is where he would arrive.

Rudolph Flesch's attack (1955) appears, to me at least, to be cheaper than Bestor's. Apparently he bases his conclusions on the observation of just one boy, although that may possibly not be the case. A significant element in his discussion is the extreme claim which he makes for his method of phonetics which he would make the only method in teaching reading and spelling. This brings to mind forcibly the case of the "Montessori Method" (Montessori, 1917) of forty years ago. At that time Montessori's method became such a fad that it swept the country like Mah Jong, Canasta, pony-tail hairdos, *The Music Goes Round and Round,* and *Sixteen Tons.* Then we had the spectacle of starry-eyed young teachers flocking to board the ships for Itlay to study Montessori's method at first hand, not at all disturbed by the fact that they did not know a word of Italian. Montessori's method of teaching reading and spelling was the phonetic method *par excellence,* and she did achieve remarkable results. In fact, Montessori was a great teacher, perhaps a genius. But eventually her name and method dropped from sight in America when we at last realized that a method of teaching a phonetic language like Italian in a school for feeble-minded children in Italy might not be so successful in trying to teach a non-phonetic language like English in an American school which had not been delegated to the feeble-minded.

Some of the attacks are made to sound so significant! One of these which Becknell *(op. cit.)* seems to think is highly significant (Koerner, 1954) appeared in Harpers recently. The author of this article concludes that our teachers are sadly uneducated, especially in reading, writing, and spelling. But his conclusions were based on just twenty-eight students who were taking an extension course, "evidently endeavoring to renew their teaching certificates by taking

this extension course." How familiar that sounds! I have had experience in extension courses, and I have seen many of these poor, pathetic teachers, most of them quite advanced in years, who had managed some way in the distant past to secure a teacher's certificate and who according to the laws of the state could get a year by year extension by taking a little work each year. These are the pitiable relics of the past with whom we have to be patient for a few more years. I confess to my shame that I have exercised some charity in awarding grades to such elderly teachers.

Some scare-head criticisms would seem to be deliberately misleading. One writer says of a Washington, D. C. junior high school that a hundred students could neither read nor write (1954). The facts were somewhat otherwise; they all could read and write, but this was a selected class of a hundred, who were well below the average, out of fourteen hundred, and they were getting special remedial training. Such criticisms appear by the hundred, and some of them are at least partially justified, but we should not go overboard before carefully testing them for their real worth.

Another point which is sometimes made, and it is being heard more frequently of late, is that we are making a poor showing in comparison with the European schools. We are. But it is rather ridiculous to attribute this to modern educational methods. We always have made a poor showing by such a comparison, especially in technical training. We have been dependent upon Europe for dye-stuffs, scientific instruments such as microscopes and binoculars, and all such physical and chemical laboratory apparatus as crucibles, heat-resisting glassware, calipers, balances, and draftsmen's tools, and nearly all our best instruments. The exigencies of World War I stimulated our producers, and since then we have been far less dependent upon Europe.

Not only have we imported our materials from across the water, but we imported our scholarship and our skilled labor. I felt embarrassed some thirty years ago when I discovered that the American firms which manufactured diesel engines with finely drawn tolerances would not allow an American trained workman to work in their factory. They insisted on German or Scandinavian workers. And we should not forget that our great achievement of late years in atomic research, radar, etc., has been helped greatly by transplanted European scholars, Einstein for example.

It would be easy, however, to overemphasize the superiority of the European educational system. In the attempt to compare the American system with that which has been prevalent in Europe, we are faced with the same type of difficulty which would be met in trying to decide which is more beautiful, a sunset or an American Beauty rose. The philosophies and methods have always been different. European countries have always aimed at developing a few outstanding scholars, whereas in America we have attempted to give as much education as possible to all. Even in old czaristic Russia there were some of the best schools on earth, and Russia produced a small number of outstanding world scholars; but as Louis N. Wilson who had been educated in one of those schools once remarked in conversation, "You can get behind a team of fast horses and drive all day and never find one person who can read and write." Even today in many parts of Europe there is a limitation on the number who may attend schools, especially after the first few grades are completed; in France, for all its boasted culture, the rigid curriculum is very limited.

Then also, we should not make the mistake of thinking that American education is beset with difficulties while all is sweetness and light in other countries. A British teacher (John Duncan, 1953) pointed out that fifteen percent of British young people have reading difficulties. Canadian educators have announced similar difficulties. Similar conditions prevail in Sweden, and in Denmark the situation is so serious that Denmark has a journal devoted to reading problems and has a special fund for remedial training of poor readers.

While we should not emphasize unduly the superiority of European education over our own, we should recognize certain grave dangers which face us. A decade ago some of us were alarmed by the fact that we were spending only one and one-half percent of our national income on education while Russia was spending eight percent for this purpose. The present day awakening to the fact that Russia is rapidly outstripping us in technical training is no more than what some of us realized was inevitable.

During the last third of a century we have made rapid and great strides toward closing the gap between American and European education. We can not retain this position, let alone improve it, unless we are willing to increase our expenditure. Europe has a surplus of teachers and may select the best, but it is different in

this country. In the January 15, 1952 issue of the *New York Times* there was a statement that of the 105,000 new teachers needed annually only 35,000 were being trained; and that only 300,000 teachers in elementary schools have college degrees, and this is just half of the number who are teaching.

The lines of criticism and complaint that are mentioned above are not the only ones along which the attack is carried. They are legion, and sadly enough they are characterized all too frequently by bitterness, prejudice, and above all by ignorance. Men of science should rise above this type of behavior. If we are to discuss any subject we should first secure what information is available. It would be utterly impossible to become acquainted with all the evidence extant in the field of educational practices. Since the beginning of this century over 100,000 studies have been made concerning the efficiency of our educational methods. Even by 1939 over 2,500 such studies had been made in the field of reading alone and over 1,100 in arithmetic (Scott and Hill, 1954). I wonder how many of these 100,000 studies have been thoroughly digested by our severe critics!

By every criterion which may be used, the evidence is that our present day methods are quite superior to those of earlier days, and also that they are getting better all the time. For one thing, even between World War I and World War II the rate of illiteracy dropped considerably in spite of the fact that in the first war any one was considered literate if he could write his own name, but in the latter war he was required to read on about the level of a third grade child (Tuddenheim, 1948).

Perhaps the most significant line of evidence is the comparsion of the performance of contemporary students with that of bygone days. There are many examination papers and other written materials which have come down from the students of earlier times. When these same tests are given to our students they do markedly better than the earlier ones did in almost every instance (Scott and Hill, 1954). One of the best known of these is the examination in spelling and arithmetic given to 254 5th grade students in 1881. Of these earlier students, fifty-eight percent made seventy or higher, but when the same test was given to 795 5th grade students in Wilmington seventy years later, sixty-four percent made seventy or above.

In 1848 forty students in Cleveland, selected because they were the best, who were between ten and nineteen years old took a special test. In 1947 forty picked students in Cleveland between twelve and fourteen took the same test and did better in every subject except history, in which they fell just a little below. This was understandable, since the history test was all about events which had occurred a hundred years or more ago.

In Indianapolis a test which had been given in 1841 was given to 5,748 high school seniors, and both the boys and girls did better than the nineteenth century youngsters. In Lincoln, Nebraska, over 5,000 students of the third to eighth grades took the same test that a similar number had taken in 1921. The later students beat the others easily in every grade. In Austin, Maine, two schools repeated a test which had been given thirty years earlier. In reading, the later students were from half a year to a full year ahead of the others, but in spelling they did not do quite so well. In Dearborn, Michigan, the same tests were given in 1926 and 1951. The contemporary students were ahead a year and a half in reading, half a year in arithmetic, two years in written and oral English, but again slightly behind in spelling. In Evanston, Illinois, a similar comparison showed the same story—the later students somewhat ahead in everything except spelling.

The evidence then is that in some cases the present day students are superior in all subjects except spelling, and even superior in spelling in some instances. The question of spelling is of special interest to me, since I am a poor speller, a very poor speller, and I seem to be getting worse. This poses an interesting problem, since I was given old time—very old time—training in spelling; furthermore I was known as an exceptionally good speller when I was a youngster in the grades. Then how shall we explain my deficiency of today? By chance I discovered that G. Stanley Hall was also a poor speller, and with his encouragement I made an investigation to see if I could explain my—our—weakness. After two years I arrived at what seems to be the correct explanation, namely that rapid and concentrated reading develops the habit of seeing words as a whole and ignoring the separate letters.

Students today surely read far more than they did in the days that are passed and gone. From the looks of things, they read more in comic books alone than their ancestors did altogether. Perhaps our educators may find a way to develop better spellers,

but let us hope that it will not be by returning to the older practice of slow reading and close attention to each letter.

It should be understood that even if modern students do not grasp the letter structure of the words they read, they are being taught to get the meaning. This was a tragic weak spot in earlier methods of teaching reading. In 1843 Horace Mann said, "More than eleven twelfths of our children in the reading classes in our schools do not understand the meaning of the words they read." Dickens realized this, even in his day, and caricatured it extensively (Hughes, 1903). The primary aim of the modern teacher is to get away from this and be sure that the students understand what they read. If in this process they slip a bit in spelling, that is to be deplored, but it is the lesser of the two evils.

The emphasis has changed in other subjects also. Even before I was in high school I could name every bone in the body. I could also trace the blood through all its valves, auricles, ventricles, veins, arteries, and capillaries. Some modern educators would say that there was no value whatever in this, but that is erroneous. I have been glad many a time that I had this information, but even though it had some value, it certainly is not as valuable as the information about hygienic rules, proper nutrition, and good health habits which I totally missed then but which are emphasized today.

Similarly, I learned the capital and one or two important cities of every state. This is something of which I am especially glad; it means so much to me when I read news accounts of different places in papers and magazines. In this time of extensive travel, it adds much to our enjoyment to have such information, and it even helps us to plan our itineraries. But again, if we do not have time for everything—and we certainly do not—it is better not to spend time on such matters as these but instead be taught about the dangers of soil erosion, for example the fact that enough good earth to make 500,000 forty acre farms is washed down our rivers every year.

We accuse our young people of being ignorant, but we are prone to forget how pitiably ignorant we were when we were in our teens. (Parenthetically, it is hardly fair to compare our status and equipment at that age with the average; without being unduly immodest, we must realize that if we are men and women of scholastic achievement today we were probably always far ahead of the average.) The young people of today know far more than

we did. We criticize them and speak belittlingly of their preoccupation with driving and working over a "hot-rod", but we forget that their ability along that line necessitates a rather profound understanding of the principles of physics. When I talk with a teen-age neighbor boy, a rather typical "hot-rodder", I am—well, flabbergasted. His knowledge of radio, television, screen grids, channels, and a voluminous list of other such things amazes me. When he demonstrates a model plane which he has made, one which will actually fly, and begins using aviator language, I just nod and try to look as if I understand some of it.

In the field of national and international affairs, the students of a by-gone day knew little more than a Stone Age man. What they did know about the constitution and government was little more than rote memory. It is somewhat different now. Picking up the local paper of this very day, I see six columns written by students of our local schools. These columns discuss in quite an interesting way the things which are happening in their schools. They study their governments at first hand, too. They visit fire stations, police courts, city halls, and bus loads of students from all over the state occasionally visit the capital and see the legislature and the Supreme Court in action. In many schools, the students take over the government of the city for a day, and often the entire school is affected for weeks beforehand by the preparations for this occasion. Moreover, they have their Boys' State and Girls' State with their governors, legislators, and other state officials. Finally, there is a group which goes to Washington and elects a president and other officials. I wish our congressmen, legislators, and other state and national officials could always discuss current issues as intelligently as I have heard these youngsters discuss them.

While the foregoing has stressed the positive values of our educational system, it must not be inferred that it stands above criticism. Sadly enough, there are many all too evident shortcomings, one of which, as noted above, is the desperate need for more well trained teachers. It is in the training of these teachers that some of the bitterest of criticisms are centered. Educators and schools of education are attacked with an intensity which is matched only by the lack of information on the part of those who make the attacks. Our schools of education are not by any means perfect. I have criticized them severely many times, and I shall do so

again. But although they have their weaknesses, I suspect that they are doing quite as good a job in their line as the rest of us are doing in our own fields.

Perhaps the most severe criticism which is levelled at our professional educators is that they overemphasize method at the expense of subject matter. This should be a legitimate criticism if it were true, and it has been true at times and in some places. But if our critics would take the trouble to inquire, they would find that our prospective teachers are now given more subject matter than they were in the days when they did not receive the training in method. This is a fact which the critics frequently will deny loudly—simply because they do not want to believe it.

The layman is inclined to deny the value of training in methods of instruction, but he would quickly change his mind if he studied the matter carefully. Not many persons are "born" teachers, and long and painful experience has shown that it is tragic to start out a new teacher without some training in methods. Even the best of the "born" teachers may profit greatly by such training, perhaps profit more than those who are not naturally gifted in teaching.

We should not hesitate to criticize our schools, but like true scientists we should be sure of our ground and not make absurd and ridiculous statements.

It has always been the practice for our older people to criticize the times and to say that things are going to the dogs. It would be well for us to ponder over what the writer of Ecclesiastes said when the disgruntled pessimists came to him with their complaints just as they do today. He replied, "Say not ye why were the former days better than these. For ye who say this have not inquired wisely concerning the matter."

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A NEW NAME FOR THE DARK RACE OF *TROPISTERNUS MEXICANUS* (CASTELNAU) FROM THE SOUTH-EASTERN UNITED STATES (Coleoptera: Hydrophilidae)[1]

Frank N. Young and Paul J. Spangler
Indiana University

An examination of large series of *Tropisternus mexicanus striolatus* (LeConte), *m. proximus* Sharp, and typical *mexicanus* (Castelnau) convinces us that the dark form which occurs in the peninsular region of Florida and in southeastern Georgia deserves recognition as an allopatric subspecies. The dark form has probably evolved under the peculiar edaphic and climatic conditions of the region, and intergrades with *striolatus* in a belt across western Florida and southern Georgia and Alabama. The distinctive characteristics of this form were recognized as early as 1883 by Sharp (*Trans. Ent. Soc. London,* 1883: 99), but no name has been suggested for it.

Various considerations lead us to believe that the darkness of the peninsular Florida and southeastern Georgia populations is not entirely due to environmental influences. It is true that dark (infuscate) specimens of *mexicanus* occur in the moister regions of Mexico and Central America, but the degree of infuscation does not apparently affect the basic pattern of the metallic green surface sheen which is so extended in most individuals of the species in Florida and southeastern Georgia. It now seems probable that the pattern, except for adventitious infuscation, is due to genetic factors, and the *striolatus*-like specimens occasionally found in Florida are due to gene flow between differing populations. It also appears that the correlation between the distribution of the dark phase and the flatwoods is not as precise as previously believed, and the range does not correspond to the extent of flatwoods areas as would be expected if only environmental influences were involved.

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[1] Contribution No. 594 from the Zoological Laboratories of Indiana University, and contribution No. 1606 from the Department of Entomology of the University of Missouri, aided by a grant from the National Science Foundation.

Tropisternus mexicanus viridis subsp. nov.

DIAGNOSIS: Very similar in size, body proportions, male genitalia, and punctation to *striolatus,* but differing strikingly in the greater extent of the metallic green sheen which makes up most of the dark pattern of head, pronotum, and elytra. From the Cuban *proximus,* it differs in the much greater extension of the metallic sheen and in the second vitta of the elytral disk which is seldom interrupted and never incomplete at the base. *Viridis* differs from both *proximus* and typical *mexicanus* in the more coarsely punctate elytra, the epipleural punctation which extends nearly or quite to the humerus, and in the larger size and somewhat different body proportions.

DESCRIPTION: The color pattern of *viridis* can be briefly characterized as follows: *Head* with vertex dark with a metallic green surface sheen which extends nearly to the anterior margin of the clypeus and is rarely divided into anteriorly extending points (or if so the points exceed the groups of antero-frontal setae). *Pronotum* with medial dark blotch with a metallic green surface sheen which often extends nearly to the margins. Blotch always broader than long, and with base nearly as wide as or wider than the apex. Margins of pronotum often dark (infuscate) or reddish brown. *Elytra* with sutural and six other distinct vittae overlain with a metallic green surface sheen. Vittae broad, often partly united, and so close together that the interstices appear as dark translucent lines rather than yellow stripes. Second vitta of elytral disk rarely interrupted, never incomplete at the base. *Venter* dark, much as in other members of the species. Length, about 7.5 to 11.0 mm.

In the holotype male the metallic sheen of the head extends nearly to the edge of the clypeus. The metallic sheen of the pronotum is extended so as to leave only a very narrow yellow border at the base and apex and on the basal third of the sides, but is broadly emarginate on either side in front leaving a broader yellowish brown margin on the anterior two-thirds. The metallic sheen of the elytral vittae is expanded leaving only traces of yellow between the bases of the outer vittae. The 4th and 5th vittae are united near the apex. Length about 9.6 mm.

The allotype female is very similar to the holotype except that the emargination of the anterior part of the lateral margin of the metallic sheen of the pronotum is shallower, and no yellow shows

between the elytral vittae except toward the apices. Length about 9.3 mm.

VARIATION: The variation in size is considerable, but the pattern of the metallic green sheen and its extent on head, pronotum, and elytra is relatively constant. Among 188 specimens selected at random from northern peninsular Florida, southern Florida, and southeastern Georgia over 91% have the metallic sheen of the head exceeding the group of anteo-frontal setae, 56% have the pronotal blotch extended nearly to the margins, and in over 88% no yellow stripes show on the disk between the elytral vittae. Only one specimen from southern Georgia has the typical pronotal pattern of *striolatus* (base narrow, anterior portion expanded) and the elytra with widely separated vittae. In western Florida, southwestern Georgia, and southern Alabama where *viridis* apparently intergrades with *striolatus,* the corresponding percentages are about 60, 36, and 42, with about 10% showing pronotal blotches typical of *striolatus* and 25% lighter elytra. In contrast, in southern Tennessee north to Indiana the corresponding percentages are 0, 0, 0, and almost 99% show the typical *striolatus* pronotal blotch and light elytra. A detailed analysis of the variation in *T. mexicanus* is in process.

HOLOTYPE MALE AND ALLOTYPE FEMALE: Alachua County, Florida. San Felasco Hammock west of Gainesville (T-9-S, R-19-W, Sec. 18), Sept. 13, 1950, F. N. Young (in UMMZ).[2]

PARATOPOTYPES: Same locality as holotype, Sept. 13-16, 1950, (22 distributed as follows: UMMZ, UF, AMNH, MCZ, USNM, CAS, CU, PA, CNHM, P. J. Spangler, and H. B. Leech).

PARATYPES (365): Specimens from the following Florida counties are designated paratypes: Alachua (109 UMMZ; 54 UF; 7 CU; 1 AMNH). Baker (3 UMMZ). Broward (2 UMMZ; 2 UF; 2 SM). Charlotte (1 AMNH). Dade (15 UMMZ; 4 CM; 1 U Cal. at Davis). DeSoto (1 UMMZ; 6 CU). Flagler (1 UMMZ). Glades (9 UMMZ). Hendry (1 SM; 1 USNM; 1 Ross Arnett coll.). Highlands (1 CAS;

[2] Abbreviation for museums in which specimens are located are:

AMNH—American Mus. Nat. Hist.
CAS—California Acad. Sci.
CNHM—Chicago Nat. Hist. Mus.
CM—Carnegie Mus.
CU—Cornell Univ.
UF—Univ. of Fla.
MCZ—Mus. Comparative Zool.
OSU—Ohio State Univ.
PA—Philadelphia Academy
SM—Snow Mus., Univ. Kansas
UMo—University of Missouri
UMMZ—Univ. Mich. Mus. Zool.
USNM—U. S. Nat. Mus.

1 UF; 17 SM; 10 CU; 2 J. W. Green coll.). Hillsborough (1 UMMZ; 1 USNM). Lafayette (1 SM). Lee (5AMNH; 4 UMo; 1 CU; 1 Leng-Leech coll.). Levy (1 UMMZ). Marion (1 UMMZ). Monroe (1 OSU). Okeechobee (2 AMNH; 2 CU). Orange (1 UMMZ; 6 CU). Osceola (1 CU; 3 UMMZ; 1 J. W. Green coll.). Palm Beach (2 UMMZ; 12 CU; 6 AMNH; 1 Leng-Leech coll.). Pasco (1 UMMZ). Pinellas (2 CU; 4 AMNH; 4 H. Howden coll.). Polk (5 UMMZ; 4 UF; 4 CNHM; 1 USNM; 1 AMNH). Putnam (7 CU; 1 USNM). St. Johns (1 CNHM). Sarasota (15 CU). Union (1 UMMZ). Volusia (3 USNM; 5 Leng-Leech coll.).

INTERGRADES: Specimens from the following counties in Florida have been excluded from the type series because individuals or series of individuals show indications of intermediacy between *viridis* and *striolatus:* Bay, Calhoun, Columbia, Duval, Franklin, Hamilton, Gadsden, Gulf, Jackson, Leon, Liberty, Madison, Okaloosa, Taylor, Wakulla, and Walton. Specimens from southern Georgia and Alabama have also been excluded, because most series contain specimens which are intermediate in nature. Counties from which material has been examined are as follows: GEORGIA: Baker, Colquitt, Decatur, Dougherty, Early, Liberty, Lowndes, Mitchell, Seminole, and Thomas; ALABAMA: Butler, Dallas, Houston, and Mobile. Most of the intergrade material studied is in the University of Florida collections (UF).

We acknowledge with sincere thanks the kindness of the curators and individuals, who have loaned us specimens for study. We also want to thank the many collectors, who contributed specimens to the various collections studied, but whose names have had to be omitted for lack of space. Thanks are also due to Sylvester N. Brown for help in collecting in western Florida and southern Alabama and Georgia; and to Joseph E. Woodruff, who prepared much of the material for study. Field work in Florida, Georgia, and Alabama was aided by a grant from the U. S. National Park Service through contract with the Florida State Museum and the Department of Biology of the University of Florida.

A HISTORICAL SURVEY OF WATER RESOURCE USE IN THE TAMPA BAY AREA [1]

James W. Covington
University of Tampa

A glance at a topographic map of the Tampa Bay region would indicate that there is an abundant supply of water available for the needs of the population. Four large rivers, including the Manatee, Little Manatee, Alafia and Hillsborough empty in the waters of Tampa Bay. Due to the average annual rainfall of 49.52 inches, these rivers have a dependable and constant source of supply and the recent drouth seems not to have affected their water level. There are numerous lakes, ranging in size from one several miles in length to small shallow grass-filled ponds, located within ten or fifteen miles from the city limits of Saint Petersburg and Tampa. There are so many lakes near a small community situated on U. S. Hghway 41 that it has been appropriately named Land O' Lakes.

Many springs may be found in Hillsborough, Pinellas and Manatee counties. The Espirito Sancto Springs at Safety Harbor has a flow of 24,000 gallons per minute. Sulphur Springs in Tampa has a flow of which varies from eight million to one hundred and five million gallons per day (Ferguson *et al,* 1947:137). There are many smaller springs which may be seen in the area. There is even one small spring located on the campus of the University of Tampa. The numerous lakes and springs are due to the subsurface limestone which is prevalent throughout the state and which makes Florida the possessor of the largest number of first magnitude springs in the United States.

With all of this fresh water available, let's take note of the way man in the Tampa Bay region throughout the years has made use of the water supply.

When the first Spanish explorers came to Tampa Bay they found the Indians had built their villages near the sea or on the banks of important rivers. These natives usually followed the custom of other North American tribes and placed the community on a fairly high positon to guard against sudden attack. In addition

[1] Read before the 20th annual meeting of the Academy at the University of Miami, December 1955.

to considering a higher spot where the village might be erected, the Indians also selected a site near a lake, spring or river so that a supply of fresh water was available (Willey, 1949:577).

After the days of Narvaez, Ponce de Leon and De Soto there were many trading vessels from Spanish ports that stopped all along the coast and exchanged beads and metal objects for furs and hides. Anclote River, a few miles north of Saint Petersburg, was of early importance, and became a port of call for the Spanish vessels travelling from Vera Cruz, Mexico to Havana, Cuba. It is said that Anclote means safe anchorage and the Spanish trading vessels anchored nearby so that the crews could come ashore to a well where they were able to refill their water casks (True, 1955:85).

A few years after the original natives, who may have been either Calusa or Timucuan Indians had died off, were captured as slaves, or retreated to the south, the Seminoles moved into the area about 1810 from the northern part of Florida. They did not settle near the Gulf of Mexico as a rule, but usually their camp sites were found along the rivers and lakes where a constant supply of fresh water was available. One well-known Seminole group led by Billy Bowlegs had their village near Lake Thonotosassa, east of Tampa, until around 1850. During the Eighteenth Century, Cuban fishermen discovered the great number of fish found in the coastal waters and made periodic visits to Southwestern Florida. They used various islands located along the coast as stations where they dried their catch during the fishing season. Many Cuban fishermen, liking the islands as a place for their homes, married Indian women, and established farms on the islands where citrus trees and garden vegetables were grown. The water supply for these settlements was probably obtained from cisterns or carried in casks from the mainland. The fishing rancho inhabitants seldom investigated the mainland but remained on the islands when they were not at sea (Covington, 1954:61).

In order to observe the Seminoles moving into their new reservation in Southern Florida and to prevent the sale of arms to the Indians by the Cubans, Fort Brooke was established in 1824 at the juncture of Hillsborough River and Hillsborough Bay. This fort slowly grew in importance until the Seminole War broke out and then it became perhaps the most important military center in Florida with as many as two thousand soldiers permanently or temporarily located there at one time. The water supply for the fort

was hauled to the garrison in barrels on mule-drawn wagons from a spring located about a mile away. Incidentally the same spring is used at the present time as one source of water supply for a brewery (Grismer, 1950:67).

Under the terms of the Armed Occupation Act of 1842 settlers were allowed to homestead in the Tampa Bay area, and if they farmed and cultivated five acres of land and lived for five years, they were given the entire quarter section of 160 acres of land. Many people took advantage of this opportunity and filed claims for many desirable tracts of land within the year and time limit of the act. Since good roads were few or non-existant, these settlers usually located their house near some river, the bay, or the gulf so that they could have good transportation. Water supplies were obtained from nearby springs, rivers, or shallow wells. Sometimes the water had an unpleasant mineral taste and consequently the pioneer boiled the water to rid it of the strange taste. The water obtained from the rivers was certainly pure since there was not much danger of pollution. The only problem of river water use was that of the salt water intrusion from the Gulf of Mexico via the tides.

By 1870 Tampa was a village of some seven hundred persons. It even had two public pumps located on the main street to supply water to the thirsty horses. The villagers obtained their water by means of shallow wells and cisterns. The wells were as deep as twelve to fourteen feet in the ground. One person made a check of the homes at that time and found that two-thirds of the citizens used cisterns as the chief source of water (Cochran, 1881:72). A cistern is an underground water storage place which collects rain water drained from the roof.

Tampa secured its first public water supply in 1889 when two thirteen hundred foot artesian wells were drilled, a pumping station was built and water lines were connected to the various homes. Water rates were fixed at eight dollars a year for service to homes (Grismer, 1950:192).

During the Spanish-American War when thousands of soldiers moved into Tampa prior to embarkation for Cuba, the water supply system proved to be inadequate for so many persons. Finally, an adequate supply of water was shipped in by boats from Mirror Lake which is now in the center of Saint Petersburg. When the military transports left for Cuba, large tanks of Mirror Lake water

were carried in the holds of the vessels in order to provide a supply of pure water for the troops when they landed (Grismer, 1947:135).

The residents of Saint Petersburg depended upon rain barrels and cisterns for many years prior to 1900. In 1902 pipes were laid to Mirror Lake and a pump was installed. The lake proved to be inadequate by 1906 and several artesian wells were dug. Some consumers protested that the water was hard but, in spite of the protests, additional wells were dug near Mirror Lake and Saint Petersburg was given an adequate water supply.

Civilization had not dealt kindly with the marvelous reserviors of water that nature had provided in the Tampa Bay region. The swamps and lowlands were drained and some springs were covered. Most damaging was the pollution of the rivers and bays. Raw sewage was deposited in Tampa Bay by means of the sewer system. The pollution ruined fishing and oyster cultivation and gas from the bay sometimes colored the paint on nearby houses. Waste from some industrial plants caused the Alafia River to become milky in color and the fish to die (*Tampa Tribune* October 13, 1955).

As the population increased, both Tampa and Saint Petersburg were forced to expand their water supply systems. Saint Petersburg now ran into serious trouble. The problem of salt water encroachment into fresh ground water became prominent in Pinellas County between 1920 and 1930 when the early municipal supply wells of Saint Petersburg began to yield salt water. Subsequently irrigation wells, other public supply wells and domestic wells began to yield salty water. Consequently Saint Petersburg abandoned its artesian wells and developed a well field in the northwest corner of Hillsborough County some thirty-seven miles distant from the city (Grismer, 1947:140).

The citizens of Tampa were not happy with the water supply obtained from artesian wells. The water was very hard and the private company which operated the system did not extend service as rapidly as the growing city demanded. Finally the city purchased the system and the Hillsborough River was selected as best source of water. A pumping station was built above the Tampa Electric Company dam and Tampa began to receive its water from Hillsborough River in 1923 and has continued to do so until the present day (Grismer, 1950:262).

The Hillsborough River has served Tampa fairly well as a source of water. Micro-organisms, at times, have released oils which have

caused objectionable odors and tastes in the past (*Tampa Tribune* October 6, 1954). In order to guarantee a supply of "taste free" water many people purchase tanks of water for drinking purposes from commercial firms which supply bottled water from their own springs. The supply of water furnished by the Hillsborough River seems ample for the needs of Tampa in the near future. Of course there have been preiods when citizens were asked to conserve water but the water shortage was due to inadequate supply lines and not an inadequate source (*Tampa Tribune* November 27, 1955).

Today there are certain problems faced both by Saint Petersburg and Tampa in regard to an adequate water supply. Saint Petersburg has done well in planning for the future. The city administration has purchased Weekiwachee Springs which are located some sixty miles to the north to insure an adequate reserve supply. This large spring is now leased to commercial interests and is not used at present as a source of Saint Petersburg's water.

The fact that Saint Petersburg secures its present water supply from wells located in Hillsborough County has caused some concer to the citizens of Hillsborough County. At least in one recent meeting of the Hillsborough County Commissioners it was suggested that an investigation be made into the lowering of the water level in private citizen's wells by the constant drain of the Saint Petersburg wells. An interesting question for some lawyer to answer is "could Hillsborough County stop Saint Petersburg from using the wells the city owns in Hillsborough County?"

Tampa has several problems which must be solved in the near future. There are several large springs near Tampa which have been available for purchase by the city but Tampa repeatedly has ignored the opportunities. Ownership of these springs is necessary to provide a supply of water for future industrial and residential needs. A city's water supply is a most important consideration when a business firm begins to inquire into a location for a proposed new factory. Thus in luring more industry to Tampa, it is better to be on the safe side and acquire the various springs than be on the doubtful side and depend solely upon the Hillsborough River.

Tampa has done its best to stop the pollution of Tampa Bay by completing a sewage treatment plant. Within a short time all of Tampa's sewers will be connected with this plant and for the first time in many years, Tampa Bay will be free of untreated sewage. It appears to some that Tampa is faced by another problem of

water pollution. One planned subdivision located two miles above Tampa on the Hillsborough River has made plans to erect a sewage disposal plant on the Hillsborough River and deposit the treated waste products into Tampa's water supply. Some citizens of Tampa have become concerned over this prospect and the Hillsborough County Commissioners have the situation under investigation by experts in the field. One suggested solution is to extend the Tampa sewer pipes to connect with the subdivision and thus prevent the danger of the discharge into Hillsborough River (*Tampa Tribune* December 1, 1955). This suggestion is an expensive solution and cannot solve the problem when widely scattered communities appear along the Hillsborough River as they are sure to do.

The author believes that an adequate check upon the sewage treatment stations will prevent any way in which the water supply of Tampa may be harmed. The fact that Tampa maintains a constant watch upon the purity of the water flowing through the system is a double check in this matter.

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NOTES ON THE TRIGLID FISHES OF THE GENUS *PRIONOTUS*

John C. Briggs
University of Florida

Despite the appearance of two recent revisions (Ginsburg, 1950 and Teague, 1951), the sea-robins of the genus *Prionotus* still offer a good many problems to the systematist. Although both of the above works are carefully done and very useful contributions, it is regrettable that each author took advantage of only a small percentage of the material then available in American museum and university collections.

In attempting to identify the sea-robins in the University of Florida collection, a considerable amount of difficulty was experienced. It was found helpful to examine supplementary material from other institutions, particularly the relatively large collection at the Natural History Museum of Stanford University.

As has been pointed out in a recent paper (Caldwell and Briggs, 1956), an initial result of this investigation was a significant extension of the known range for *Prionotus punctatus* (Bloch) together with a clarification of its synonymy. This species is now considered to be very widespread extending from the Georgia coast to Argentina (38° S. Latitude) and to the northern Gulf of Mexico.

In the Western Atlantic there are three species which form a natural group identified by the presence of a large, stemmed, supraocular cirrus and a pectoral fin ray formula of 14 + 3. These are *P. grisescens* Teague, *P. murieli* Mowbray, and *P. ophryas* Jordan and Swain. They are fully described by Teague (1951) and may be readily separated by using his key. Due to an unfortunate lack of material, only one of the three was treated by Ginsburg (1950, p. 507).

Of the three recognized species in the aforementioned group, two are rare. *P. murieli* is known only from the holotype taken on the Cay Sal Bank between Florida and Cuba. *P. grisescens* is known from the holotype and four paratypes all taken near Tortugas, Florida and a single specimen from off the Florida east coast captured by the Belgian training ship "Mercator". The Uni-

versity of Florida collection (U.F. 7088) has an apparently typical specimen of *P. grisescens* which was taken by a trawler 30 miles northeast of Loggerhead Key. However, another specimen (U.F. 1567) collected by the U. S. Fish and Wildlife Service Vessel "Oregon" from the northeastern Gulf of Mexico (30°00′ N., 87°08′ W. at 23 fathoms) shows some interesting variations. It differs from both the written description of the species and the specimen at hand by having no squamation on the chest, no nasal cirrus, and the median ridge of the first dorsal spine more strongly serrated.

Figure 1. *Prionotus grisescens* Teague. Drawn from a specimen of 153 mm. standard length (U. F. 1567).

Ordinarily the above differences might be deemed sufficient for the recognition of a new species. In this case, however, the nearest relative *(P. grisescens)* has been described from only six specimens, five of them collected in a single location, so that comparatively little is known about the variation within the species. Furthermore, since the form in question is represented only by a single specimen (153 mm. in standard length) it was thought best to simply refer to the differences and to provide a figure (Figure 1) in the hope that the matter may be cleared up at some future date when more material is available.

The most interesting find in the Stanford collection was a single specimen from the coast of Costa Rica which is so sharply differentiated from all other prionotids that there is no question of its being a representative of an undescribed species.

PRIONOTUS TEAGUEI, new species

Figure 2

DIAGNOSIS: A small *Prionotus* with the upper free pectoral ray noticeably elongate, 2.0 in standard length, and more or less lanceolate in shape. Dorsal X, 12; anal 11; pectoral 13 + 3.

DESCRIPTION: Body of medium depth and width, depth 4.3 and width 4.9; head of medium length, 2.3; all in standard length. Snout 2.3; maxillary 2.4; eye 3.9; interorbital space very narrow, 8.0; nape short, 7.1; nape width 4.8; all in head length. Pectoral fin of medium length, 1.7; pelvic fin medium in length, 3.4; both in standard length. First dorsal spine length, 2.7; second dorsal ray 2.2; preopercular spine 6.3; opercular spine 4.8; humeral spine 7.1; all in head length. Lateral line pores 51 + 5. Seven rows of scales above the lateral line and 17 below. Gill rakers on the first arch 0 + 7.

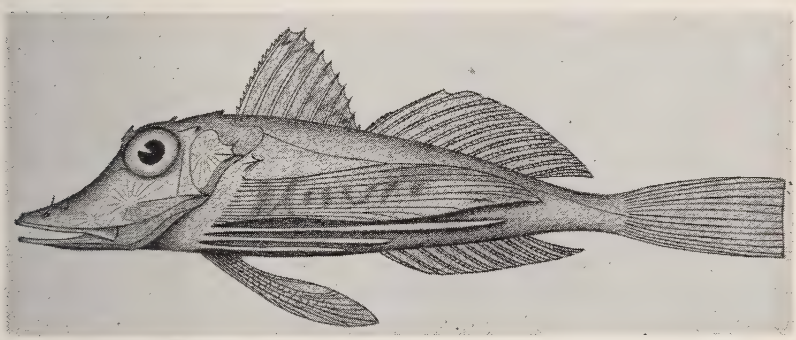

Figure 2. *Prionotus teaguei*, new species. Drawn from the holotype 62.5 mm. standard length (S. U. 46380).

Rostral, preorbital, and suborbital spines absent. Supplementary preopercular spine also absent (only a serrate ridge with terminal spinules extends almost to end of preopercular spine). Preocular spine strong, elevated; postocular strong, depressed. Sphenotic spine absent but pterotic well developed; parietal strong, elevated, and occupying a whole ridge. Nuchal spine strong, slightly elevated; postfrontal groove well defined and at the front of a depressed area. Eyes prominent but orbital region not abruptly elevated. Rostral plates not produced, bluntly serrulate, and broadly rounded from a dorsal view. Interorbital space concave. Opercular flap

scaled. Caudal fin truncate. Median ridge on first dorsal spine evenly serrate; second and third dorsal spines smooth. Median ridge of first dorsal ray serrated on the proximal quarter. Nasal flap long and well developed.

Coloration: In alcohol, aside from the first dorsal and pectoral fins, there is virtually no pigmentation remaining, probably a result of 18 years of preservation. The upper third of the pectoral shows an even light brown color, the ray being considerably lighter than the membrane between. As is shown in Figure 2, there are two vertical, dark brown bars toward the base of the fin and some shorter markings further out. The first dorsal has only some faint brown markings on the distal end between the spines. The rest of the body is a uniform light yellow and reveals no other noticeable coloration.

Relationship: When the key to the species of *Prionotus* presented by Teague (1951, p. 5) is utilized this new species will be identified as *P. albirostris* Jordan and Bollman and, indeed, this form is its closest relative. However, there are numerous differences, the size of the first free pectoral ray being the most conspicuous. The length of this ray was found to occur 3.4 times in the standard length of a specimen of *P. albirostris* comparable in size to the type of the new species. This may be contrasted to the condition in *P. teaguei* where the ray fitted but 2.0 times in the standard length. Other differences of importance are found in the head length, interorbital space, nape length, pelvic fin length, first dorsal spine, second dorsal ray, preopercular spine, opercular spine, and humeral spine. There are also no definitely developed rakers on the upper limb of the first gill arch of *P. teaguei* and the sphenotic spine is absent.

Holotype: Stanford University number 46380; 62.5 mm. in standard length taken by the Eastern Pacific *Zaca* (1937-38) Expedition of the New York Zoological Society at 9°19′32″ N., 84°29′30″ W., 14 miles southeast of Judas Point, Costa Rica, on March 1, 1938.

Remarks: All counts and measurements given in this paper have been taken in accordance with the methods listed by Teague (1951). Also, his descriptive procedure has been followed so that the account of this species will be directly comparable to his representations of the other members of the genus.

This interesting new species is named for Mr. Gerard Warden Teague in recognition for his excellent work on this group of fishes and also in gratitude for his assistance in identifying the triglids in the University of Florida collection.

Prionotus xenisma Jordan and Bollman is apparently quite rare and has been known only from the Gulf of Panama. The Stanford collection was found to contain 12 specimens (S.U. 46308) of this species from Santa Inez Bay, Baja California, Mexico. This represents a notable range extension of some 2700 miles to the north. Also three additional specimens (S.U. 46309) were found that had been taken further to the south in the Gulf of California (Arena Bank near Punta Arena del Sur, Baja California, Mexico).

Prionotus gymnostethus Gilbert is also an apparently rare species, having only been taken a short distance west of the tip of Baja California (23°33′00″ N., 110°37′00″ W.). It was therefore interesting to find among the Stanford material specimens from two localities within the Gulf of California, one individual (S.U. 46310) from Ceralbo Channel (24°09′ N., 109°57′ W.) and two (S.U. 46313) from the Arena Bank, Baja California.

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ASSESSMENT OF THE EFFECT OF COMMERCIAL CLOUD SEEDING IN NORTH FLORIDA AND SOUTH GEORGIA, 1955-1956 [1]

Werner A. Baum, Stanley E. Asplund, Robert M. Henry, William H. Long, and Stanley L. Rosenthal
Florida State University

During the spring of 1955, a group of north Florida and south Georgia citizens with interests in agricultural and timber resources was attracted by the possibility of increasing the yield of rain clouds by ground-based seeding with silver-iodide particles. Representatives from a score of counties, suffering from drought conditions at the time, met with representatives of a commercial "cloud-seeding" organization. As a result, there was formed a non-profit corporation, called the Citizens Water Conservation Association. This Association entered into a contract with the cloud-seeding service for a one-year program beginning on 1 July 1955. This was the first such large-scale operation to be carried out in the State of Florida.

In the spring of 1956, recognizing the tremendous potential value of such a program if successful, and realizing that its success or failure would not be evident from casual observation, the Board of Control requested the Department of Meteorology at Florida State University to undertake an evaluation of the results.

It was realized at the outset that, with limited time, data, and funds, no answer could be sought to such basic questions as "Can man make it rain?" or "Under what conditions (if any) can rainfall be increased?" or "What methods are most effective?" Instead, attention was directed to the question of whether detectable increases of precipitation had occurred as a result of the particular operation carried out in north Florida. It was anticipated that results in this region might be substantially different from those in other areas and/or based on other methods of seeding.

Since the operations were carried out as a commercial venture rather than as a carefully controlled scientific experiment with randomized seeding operations, it was not to be expected that

[1] This study was made possible by a release of emergency funds by the Budget Commission of the State of Florida.

even this limited objective would yield a hard and fast "yes or no" answer. However, it was hoped that a detailed and accurate statistical study might assist the people of Florida in making informed decisions as to the continuation or extension of the seeding program, and at the same time contribute to the growing fund of statistical data which will eventually help to answer many of the other questions concerning weather modification.

Methods of Evaluation

Basic Principles. In a scientific assessment of the effect of cloud-seeding activity, we seek to compare the precipitation in a *seeded* situation with that in an *unseeded* situation in which all other precipitation-producing factors are identical. Unfortunately, we cannot control these other factors; nor can we measure them sufficiently well to assure that they are indeed identical in two situations. When pairs of situations in which the extraneous causal factors are identical cannot be obtained, the scientist's alternative is to obtain samples of situations in which the effects of these factors are distributed in a random manner. Statistical techniques may then be applied to these random samples.

Ideally, the randomization would be accomplished by a random choice of the situations in which the seeding is performed. However, this requires a program determined in advance of the seeding. Furthermore, it requires the operator occasionally to refrain from seeding in what appears to be a favorable situation. A commercial operator, naturally, is reluctant to do this. Therefore, in the present instance, the samples must come from the historical precipitation record.

It is desirable that the samples used be as large as possible. There is, of course, only a single year of record of "seeded" precipitation in this case. The size of the sample historical data for "unseeded" precipitation is limited only by the adequacy of the historical record. In this particular case, it was found that adequate data for determining reliable values of the areal averages used in the study existed for the years from 1929 on to the time of seeding.

Regression Techniques. For the evaluation of commercial cloud-seeding operations, some form of regression technique has generally been found to be the most satisfactory method. In this technique as used here, an estimate or "prediction" of the precipitation in

the target (seeded) area is made on the basis of (1) a historically-established relation between precipitation in the target area and some control area during times of no seeding and (2) the precipitation in the control (unseeded) area during the seeding operation. The prediction is then compared with the precipitation actually observed in the target area.

Some evaluators, as Lincoln (1955) and Godson (1955), have used multiple regressions involving more than one control area and other controls such as wind direction, temperature, and moisture. However, the resulting improvement has generally been rather small. In the present case, there is only one control area available. A detailed study of the effects of including meteorological elements in the regression was not made; but it does not appear likely, *a priori,* that similar meteorological factors will produce substantially different effects in target and control areas. Therefore, no attempt was made to establish multiple regressions.

Control Area. Selection of a control area for the north Florida seeding project was limited by (1) the operation of silver-iodide generators to the south, north and northwest, (2) the absence of data over the Atlantic Ocean to the northeast, east and southeast, and (3) the absence of data over the Gulf of Mexico to the southwest. Within the remaining area to the west of the target, two areas of differing westward extent were chosen (Figure 1). The eastern boundary was separated from the target area by just enough distance to exclude all generators, it being assumed that the generators would be operated only when they were upwind from the target.

It was found that the precipitation in the smaller, closer control area was more closely correlated with that in the target area in the winter. The larger control area was better correlated with the target in the summer. This result might be expected on the basis of physical reasoning. Summer precipitation is mainly in the form of scattered showers and thunderstorms, whose variation is associated with large-scale features of the atmospheric circulation pattern. In winter, precipitation occurs principally with the passage of relatively narrow frontal zones. The latter are more likely to have a selective effect, due to modifications undergone while traveling through the southeastern United States or due to following a selective track.

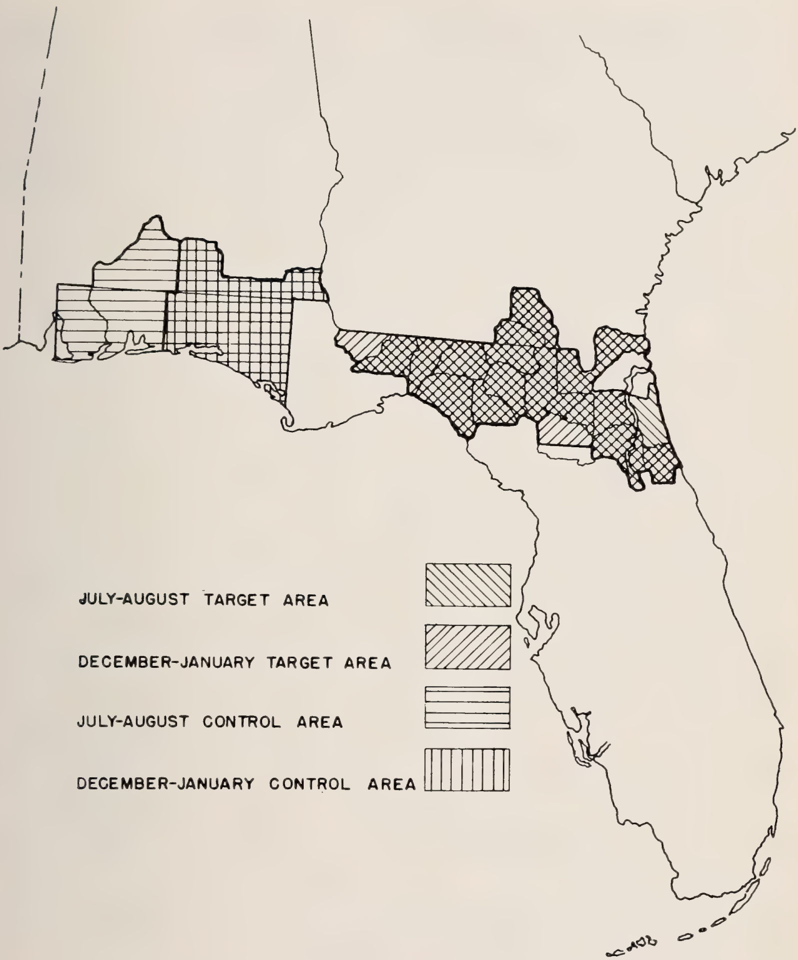

Figure 1. Target and control areas for the summer and winter seasons.

Time and Space Units. In the selection of the time interval for the precipitation unit, consideration was first given to the so-called "storm" unit or synoptic-type unit which gave good results when applied under the unique conditions found in California (California State Water Resources Board, 1955; Advisory Committee on Weather Control, 1956). It did not prove to be desirable or feasible to apply this unit to the north Florida region, on four counts. First, it was not possible to determine importantly differ-

ent synoptic types for this region on the basis of limited study. Second, the natural variability of precipitation amounts for short periods is too great. Third, particularly in summer, the beginnings and endings of "storm" periods would be difficult, if not impossible, to determine in a meaningful fashion. Finally, it was felt that any system of selection of "storm" based on periods of raininess would introduce a bias into the evaluation. Monthly totals are much more tractable. To eliminate any possible effects of serial correlation, or persistence, consecutive months were combined into seasonal totals.

The large spatial variability of precipitation amounts, even when accumulated over fairly long time periods, precludes the establishment of useful regressions between point values, and some sort of areal average must be obtained. Weighted areal averages, based on the Thiessen polygon method, were tested in a pilot study. It was found that this weighting resulted in magnifying the effect of occasional very large amounts of precipitation when they happened to occur at one of the relatively heavily weighted stations. Since the random spatial variations greatly exceed the systematic gradients of precipitation in the area concerned, and since the rain gauges were found to be generally well distributed, a simple arithmetic mean of all reported values of precipitation in the respective areas was chosen as the most appropriate representation of the precipitation amount. It may be noted that this choice has one great advantage: in dealing with records which are incomplete for some periods, one need neither discard them nor fill them in by some artificial scheme of estimating the missing values.

As has already been indicated, the type of weather situation which produces the majority of summer rainfall is quite different from that which produces most of the winter precipitation in the region. It therefore appears quite possible that, if cloud seeding produces an effect, the effect might be distinctly different in the two seasons. For this reason, separate evaluations were made for summer (July and August) and winter (December and January). The months from September through November, the only other ones for which data were available, were excluded from the study for a variety of reasons. First, the precipitation-producing situations of these months are neither the winter nor the summer type, but a combination of both. Second, the occurrence of many

hurricanes and other tropical disturbances during these months tends to increase the variance of the precipitation distributions and reduce the correlation of precipitation amounts in adjacent areas. Finally, during the autumn of 1955, seeding operations were suspended in about a quarter of the contract area for periods ranging from two weeks to two months.

Construction of Regression Curves

To proceed with the regression analysis, it is necessary to make certain assumptions regarding the frequency distributions of precipitation amounts in the two areas, and regarding the form of the relationship of precipitation amount in the target area to that in the control area.

Normality of Distributions. The standard regression theory applies only to variables having a normal frequency distribution. As accumulated precipitation amounts for short time periods do not follow the normal distribution, although totals approach normality for longer periods of time, a transformation of the data is often made to a new variable whose frequency distribution approximates the normal distribution more closely. Various transformed variables such as the square root of precipitation (California State Water Resources Board, 1955) and the cube root of precipitation (Stidd, 1953) have been suggested. Elliott and Strickler (1954) state that areal averages of seasonal totals appear to be normal without transformation. Recently Thom (1955) has suggested a transformation based on the assumption that the frequency distribution of precipitation is the so-called incomplete gamma distribution. The incomplete gamma distribution is realistic in several important ways: it is bounded at zero, its skewness can be varied by varying the parameters of the distribution, and it can be made to approach normality as the actual rainfall distribution does for long-period values. The gamma transformation has been used by the Advisory Committee on Weather Control, and it is also used in this study.

With all its advantages, however, even the incomplete gamma distribution falls short of true representation of actual precipitation, at least in the region here considered. It is this lack of better theoretical understanding of precipitation frequency distributions that constitutes one of the greater weaknesses of cloud-seeding evaluations.

In view of this uncertainty, regression equations were found both for the raw two-months precipitation totals and for these totals subjected to the incomplete gamma transformation.

As a matter of precaution, chi-square tests for probabilities of normality were made on the frequency distributions of both raw and transformed two-months precipitation totals in both target and control areas. The probabilities that a random sample from a normal population would deviate from the ideal by as much as or more than our sample did were as follows:

	Raw data	Transformed data
Targaret area, summer	0.8	0.1
Control area, summer	0.2	0.4
Targaret area, winter	0.8	0.4
Control area, winter	<0.01	0.1

With the exception of the raw data for the control area in winter, the results are not significantly different from what might be expected of samples of this size drawn from a normal distribution, and there is no reason, on the basis of this test, to reject the hypothesis that the populations are normal. As regards raw data for the control area in winter, the probability that a random sample drawn from a normal population would be as unusual as this sample is less than 0.01; hence, no quantitative results based on raw data in winter are presented.

Form of the Relationship. It is always mechanically possible to employ the method of least squares in fitting a straight line to a set of points. Once this line has been fitted, one can obtain a crude estimate of one of the variables upon being given the value of the other variable. However, if regression theory is to be used to make probability statements about the estimated variable, the problem becomes considerably more complex than the simple mechanical procedure of fitting a straight line by the method of least squares.

Regression theory is applicable when one works with two or more variables whose parent populations are correlated. That this is so in our case is apparent from the scatter diagrams (Figs 2 to 5.) The correlation coefficients between the raw data in the target and control area are 0.67 in the winter and 0.54 in the summer. For the transformed data, the coefficients are 0.69 in

the winter and 0.58 in the summer. In such a case, the variables are said to be jointly distributed.

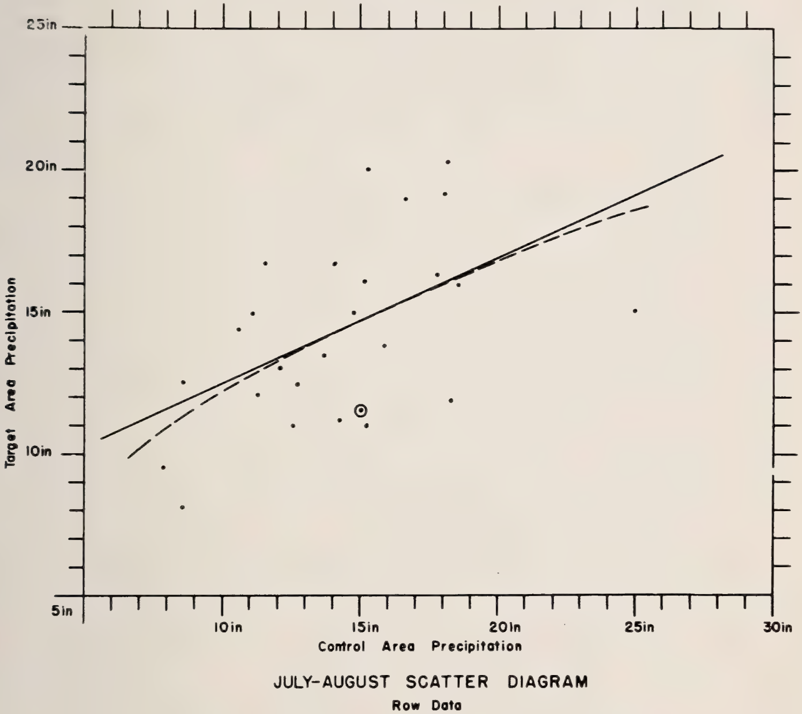

Figure 2. Scatter diagram for raw precipitation data in the summer. The solid line is the least-squares fit to these data. The dashed line is the regression curve resulting from assuming an incomplete gamma distribution for precipitation amounts. The circled dot represents the seeded 1955 season.

Denote one of these correlated variables (control-area precipitation) by x, and the other (target-area precipitation) by y. For some given value of x, say x = a, the various values of y will have certain probabilities of occurrence. For other values of x, say x = b or x = c, the various values of y will, in general, have different probabilites of occurrence. In other words, for each value of x there is a frequency distribution of y; and, in general, for each value of x the frequency distribution of y will have a different mean.

The true regression curve is that curve on the xy-plane which joins the means of the frequency distributions of y correspond-

ing to each value of x. This regression curve may or may not be a straight line, the form of the curve depending upon the frequency distributions of the variables x and y. In the particular case in which x and y are both normal variables, as has been indicated to be the case here with the exception of raw data in winter, the regression curve is indeed a straight line. We may then write the equation for the regression line in the form

$$\bar{y}_x = mx + b.$$

In this equation, x and y are the two normal variables. $\bar{y}_x$ represents the mean of the frequency distribution of y and for an assigned value of x. m and b are, respectively, slope and intercept parameters.

To estimate the values of m and b, we apply the principles of maximum likelihood estimation as discussed in any text on mathematical statistics (*e.g.*, Mood, 1950). When x and y are normal variables, the formulae for m and b resulting from maximum likelihood estimation turn out to be exactly the same as those obtained from the mechanical procedure of fitting a straight line by the method of least squares.

Thus, when x and y are each normal and are correlated, both least squares and regression theory yield the same line. This is a consequence of the joint normality of x and y, and is not true in general. If x and y are correlated but not normal variables, the curve obtained from regression theory will in general be different from the straight line obtained by fitting with least squares.

It has already been pointed out that the incomplete gamma distribution is probably a better approximation to the frequency distribution of accumulated rainfall than is the normal distribution. Thus, to operate with standard regression theory, which requires x and y to be normal variables, we must make a transformation which will take our incomplete gamma variable into a normal variable. The details of this transformation have been discussed by Thom (1955).

After the raw precipitation totals have been transformed to normality, we employ regression theory and maximum likelihood estimation to obtain the regression line, which will now be identical to the the least-squares straight line. These lines are illustrated in Figs 3 and 5 for the summer and winter seasons, respectively.

If we wish to see what the regression looks like with respect to the raw data, the simplest procedure is to pick several points off the regression line for the transformed data, work the inverse of the transformation, plot these retransformed points on the raw-data scatter diagram, and join them by a smooth curve. These curves are illustrated by the dashed curves on Figs 2 and 4. (The solid lines on these figures are the least-squares fits to the raw data.)

As might be anticipated, for these particular samples the dashed curves do not depart to any great degree from linearity. This is due to an effect previously discussed and supported by the results of the chi-square tests; since the frequency distribution of accumulated rainfall approaches normality as the period of accumulation increases, and since our data represent precipitation accumulated over a two-months period, the data probably do not depart to any great extent from normality.

Probabilities of Departures. To obtain the probability of a given departure of y from the value called for by the computed regression line, two factors must be taken into account.

First, the computed regression line is only an estimate of the true population regression line. It is therefore subject to sampling errors. Second, even the true regression line joins only the means of the distributions of y. Any one value may, of course, depart from the mean.

With both of these factors being considered, confidence intervals for the estimated variable y may be constructed. The derivation of these confidence intervals is found in many texts on mathematical statistics (*e.g.*, Mood, 1950). These confidence intervals turn out to be such that at any level of confidence, say the 95 per cent level, they are delimited by hyperbolae, one above and one below the regression line.

The hyperbolae are closest together, and the confidence interval narrowest, at that value of x which is the sample mean of x. As one departs in either direction from the mean value of x, the confidence interval becomes wider. Thus, the probability of a given departure from the regression line will be least at the value of x equal to the sample mean, and will increase as we depart from the mean. In terms of the specific problem, it is apparent that a given departure from the regression

line becomes more significant as the control-area precipitation approaches the control-area mean for the historical period.

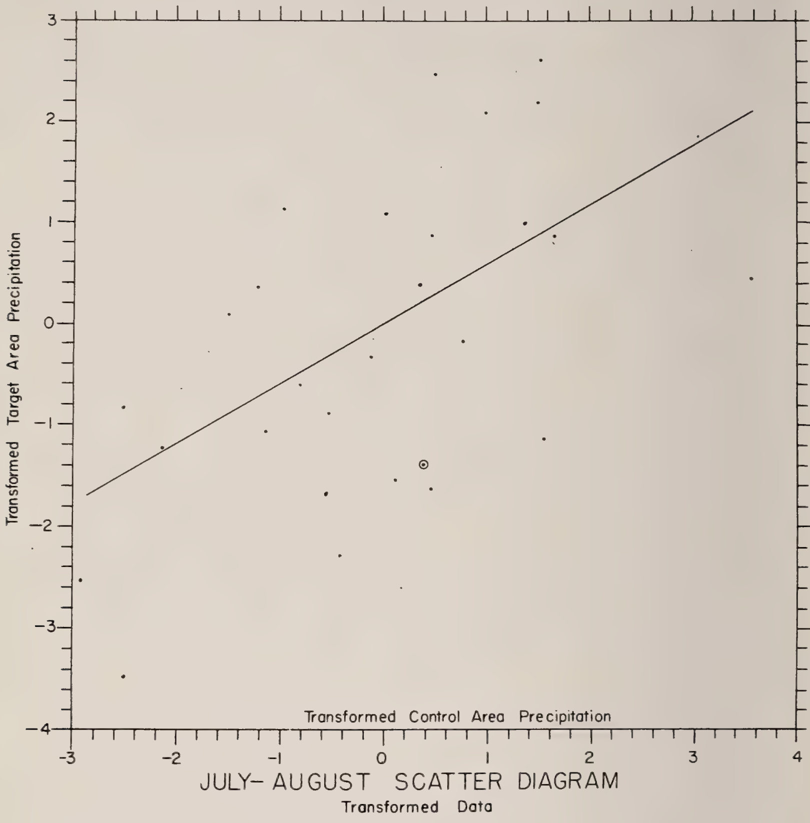

Figure 3. Scatter diagram for transformed precipitation amounts in the summer. The solid line is the regression line and corresponds to the dashed curve of Figure 2. The encircled dot represents the seeded 1955 season.

Discussion of Results

Values for the probabilities of increases or decreases of precipitation in the target area were computed under the assumption that the raw values of the areal averages of two-months precipitation totals are normally distributed. Another set of values was computed under the assumption that these totals are distributed according to the incomplete gamma distribution. Once the gamma transformation has been made, the computation of probabilities

follows the standard statistical procedure for normally distributed variables.

Table 1 contains the computed probabilities of various increases and decreases in the summer of 1955 on the basis of the assumption that the raw precipitation values are normally distributed. Results based on raw data for the winter are omitted, because of the low probability of normality of these data found by the chi-square test. Tables 2 (summer) and 3 (winter) contain the probabilities on the assumption that the precipitation data follow a gamma distribution.

TABLE 1

Probabilities of various effects on accumulated rainfall of July and August 1955 in target area, as determined from raw data.[2]

Effect	Chance
Increase of >4.5 inches	<1/100
3.5 to 4.5 inches	≈1/100
2.5 to 3.5 inches	≈2/100
1.5 to 2.5 inches	≈3/100
0.5 to 1.5 inches	≈5/100
<0.5 inches or decrease of <0.5 inches	≈7/100
Decrease of 0.5 to 1.5 inches	≈10/100
1.5 to 2.5 inches	≈13/100
2.5 to 3.5 inches	≈14/100
3.5 to 4.5 inches	≈13/100
4.5 to 5.5 inches	≈11/100
5.5 to 6.5 inches	≈8/100
6.5 to 7.5 inches	≈6/100
>7.5 inches	≈7/100

The figures in these tables represent the probabilities that increases or decreases of the stated amounts were produced during the period of seeding by factors not accounted for by the statistical relationships which are represented by the regression lines and the assumed normal distributions accompanying them. Possible natural factors not included in these historical statistical relationships are long-term climatic trends or quasi-cyclic effects with long periods which might result in average precipitation relations at the end of the historical period being different from relations during the period. It is not likely that such effects would be

[2] Observed control-area rainfall: 14.96 inches. "Predicted" target-area rainfall: 14.65 inches. Observed target-area rainfall: 11.46 inches.

of appreciable magnitude for the length of period involved in this or similar studies. Conceivable artifical factors not included are, in addition to the seeding activity under study, atmospheric pollution by recently constructed industrial plants and other, unreported cloud-seeding activity in the area involved. There is no ready means of evaluating the magnitude of such possible effects.

TABLE 2

Probabilities of various effects on accumulated rainfall of July and August 1955 in target area, as determined from transformed data.[3]

Effect	Chance
Increase of >4.5 inches	<1/100
3.5 to 4.5 inches	<1/100
2.5 to 3.5 inches	≈1/100
1.5 to 2.5 inches	≈2/100
0.5 to 1.5 inches	≈4/100
<0.5 inches or decrease of <0.5 inches	≈8/100
Decrease of 0.5 to 1.5 inches	≈11/100
1.5 to 2.5 inches	≈13/100
2.5 to 3.5 inches	≈14/100
3.5 to 4.5 inches	≈13/100
4.5 to 5.5 inches	≈11/100
5.5 to 6.5 inches	≈8/100
6.5 to 7.5 inches	≈6/100
>7.5 inches	≈7/100

Looking at the probability figures in Tables 1 and 2, one sees that the most likely event in July-August of 1955 was a decrease of between 2.5 and 3.5 inches in the two-months total rainfall in the target area. A more precise figure for the value having the greatest likelihood may be obtained by subtracting the observed target-area precipitation from the estimated or "predicted" precipitation. The probability of *some* increase (the sum of the individual values for increase categories) is 0.11 on the basis of Table 2. Similarly, the probability of an increase of *1 inch or more* is 0.05. The nearness of the values in Tables 1 and 2 results from the facts that (1) the use of the gamma transformation had little effect on the apparently normally distributed raw data in summer and (2) the observed control-area precipitation

[3] Observed control-area rainfall: 14.96 inches. "Predicted" target-area rainfall: 14.64 inches. Observed targaret-area rainfall: 11.46 inches.

of 14.96 inches was very near the mean control-area precipitation of 14.28 inches.

In December-January, because of the apparent lack of normality in the raw data, only the transformed data are considered (Table 3). The probability of *some* increase is 0.63; the probability of an increase of *1 inch or more* is 0.35. The transformed data indicated that the event having the greatest likelihood in the winter was an increase of 0.55 inches. The difference between this value and the 0.02-inch increase indicated by the raw data (Fig 4) is accounted for largely by the apparent non-normality of the raw data, in conjunction with the fact that control-area precipitation was only 4.95 inches, much lower than the average control-area precipitation of 8.94 inches.

TABLE 3

Probabilities of various effects on accumulated rainfall of December 1955 and January 1956 in target area.[4]

Effect	Chance
Increase of >3.0 inches	≈1/100
2.0 to 3.0 inches	≈10/100
1.0 to 2.0 inches	≈24/100
0.0 to 1.0 inch	≈28/100
Decrease of 0.0 to 1.0 inch	≈20/100
1.0 to 2.0 inches	≈10/100
2.0 to 3.0 inches	≈4/100
3.0 to 4.0 inches	≈2/100
>4.0 inches	≈1/100

Evaluations were also performed separately for the western and eastern portions of the target area. The results did not differ substantially from those for the area taken as a whole except that, as might be expected, the correlations with control-area precipitation were higher for the western portion of the target area than for the eastern portion.

While the evaluation was not concerned with the physical basis of cloud seeding by ground-based silver iodide, it is noteworthy that the results are qualitatively in agreement with expectations on physical grounds. Any rain-stimulating effect which silver iodide may have is supposed to occur in supercooled water

[4] Observed control-area rainfall: 4.95 inches. "Predicted" target-area rainfall: 3.86 inches. Observed target-area rainfall: 4.41 inches.

clouds which extend above the freezing level but not to great heights above that. In summer, clouds of these specifications are relatively rare, the typical clouds being (1) shallow cumulus not extending to the freezing level and (2) enormous cumulonimbus extending to great heights. In the winter, on the other hand, clouds of the specified characteristics are relatively common. Further, the silver iodide must rise to much greater distances above ground in the summer than in the winter to find the temperatures at which its rain-stimulating effect is supposed to occur.

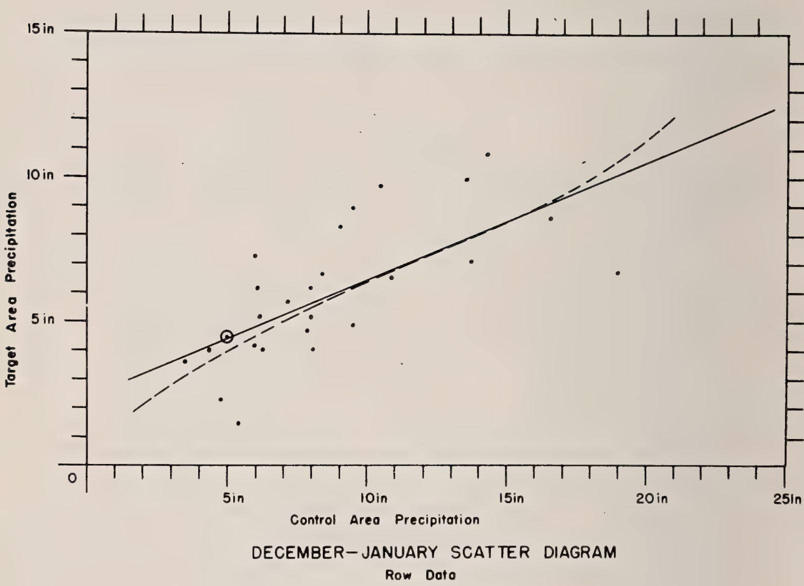

Figure 4. Scatter diagram for raw precipitation data in winter. The solid line is the least-squares fit to these data. The dashed line is the regression curve resulting from assuming an incomplete gamma distribution for precipitation amounts. The circled dot represents the seeded season.

Summary

The evaluation procedure leads to the conclusion that the effect which was most likely was a decrease of about 3 inches in the total precipitation for July and August 1955, and an increase of about ½ inch in the total precipitation for December 1955 and January 1956. The probability of *some decrease* in the summer months was 0.89, and that of *some increase* in the winter months

was 0.63. These figures should be interpreted in the light of the possible errors in measurement and averaging, the uncertainties of the nature of the frequency distributions of precipitation and the form of the regression equation for precipitation on adjacent areas, and the possible existence of artificial effects not known to the evaluators. In addition, caution should be exercised in ascribing these departures to the effects of cloud seeding, since decreases as great as that found in the summer might be expected to occur about one year in ten, and increase as great as that found in the winter about four years in ten, simply as a result of the random variation of precipitation due entirely to natural causes.

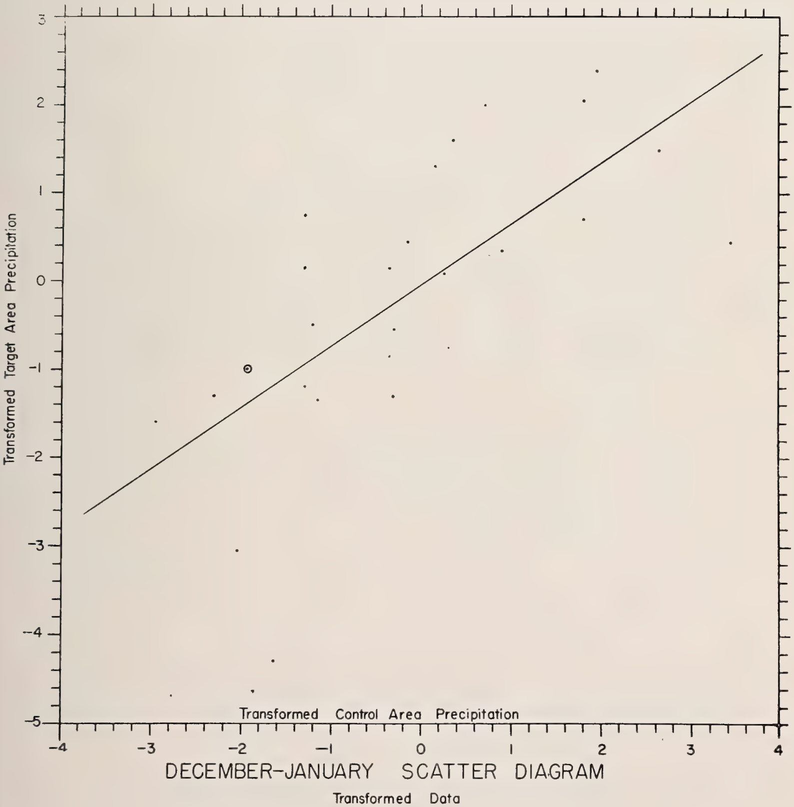

Figure 5. Scatter diagram for transformed precipitation amounts in the winter. The solid line is the regression line and corresponds to the dashed curve of Figure 4. The circled dot represents the seeded season.

The question of whether the various results cited are beneficial or harmful to any individual depends on how that individual's activities are affected by variations in precipitation. This question is outside the scope of this study.

Acknowledgment

The authors are greatly indebted to Dr. Alvin Fend, formerly Assistant Professor of Statistics at Florida State University, for many helpful discussions.

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THE OPERATION OF THE PHARYNGEAL BULB IN THE ARCHIANNELID *DINOPHILUS*

E. Ruffin Jones
University of Florida

The muscular bulb of the pharynx in the Archiannelids is a very interesting and unique organ lying in a pocket off of the posterior wall of the foregut. Its structure, the peculiar type of muscle occurring in it and its probable phylogenetic significance were discussed in detail in an excellent paper by Jägersten (1947). However, in regard to its operation Jägersten makes only this statement: "The bulb functions when food is ingested probably as a kind of tongue.", and I have been unable to find in the literature any other reference to its method of functioning.

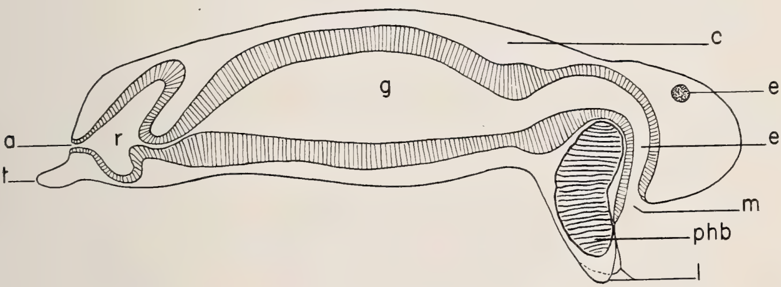

Figure 1. An optical section of *Dinophilus kincaidi* drawn from a whole mount. X 150 Approx.

a	anus	*l*	lobes or lips formed by protrusion of pharyngeal bulb
c	coelom	*m*	mouth
e	eye	*phb*	pharyngeal bulb
es	esophagus	*r*	rectum
g	midgut	*t*	tail or caudal appendage

During a recent study of three species of the genus *Dinophilus* including two new species (Jones and Ferguson—1956) a number of specimens which had been fixed with the proboscis pushed out of its pocket were encountered. This together with observations on the food and feeding habits of the three species suggested a theory as to the role of this interesting organ in the feeding process. As is shown in Figure 1, the bulb when protruded lies just behind the mouth, appears somewhat bipartite, and is a little

reminiscent of the tusks of a boar or elephant. The three species of *Dinophilus* which we studied all feed on diatoms and other organic material from the bottom. It seems probable, therefore, that the muscular bulb serves as a scoop to scrape up material from the bottom substrate and direct it into the mouth. This method of feeding might be compared to the operation of the horse drawn scoops which were at one time extensively used to remove surplus soil in building roads, foundations, levelling ground and other similar operations. The scoop did not dig deeply but merely scraped along the top until it had scraped off enough soil to fill it, when it was hauled off and dumped. The Dinophilids probably swim or crawl slowly along the bottom with the proboscis bulb protruded and it scrapes the surface not digging deeply enough to make the going too heavy for the animal, but effectively scooping out a shallow furrow in the substrate. The material thus plowed up is directed into the mouth and the organic portion is used for food while the remainder is discarded.

The small size of the Dinophilids and the difficulty of observing the actual ingestion of food have thus far precluded the possibility of verifying this theory by direct observation, but it is hoped that this may be done at a later date if living material can again be secured. However, the firmness and massiveness of the bulb do not support Jägersten's (1947) suggestion that it functions as a tongue and there is nothing in its structure which suggests any other type of action such as chewing, sucking, grinding, etc. On the other hand the relationship of this muscular pharyngeal bulb to the mouth, and its appearance and orientation when protruded, together with the known feeding habits of the Dinophilids all support the logic of the "scoop" method of operation which I have suggested.

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AN ANNOTATED BIBLIOGRAPHY OF RED TIDES OCCURRING IN THE MARINE WATERS OF FLORIDA

ROBERT F. HUTTON
Florida State Board of Conservation Marine Laboratory
St. Petersburg, Florida

'Red Tide' is a popular name given to discolored waters caused by the aggregation or tremendous increase (blooming) of microscopic organisms. This name was evidently coined for the phenomenon occurring along the west coast of Florida wherein a species of dinoflagellate, *Gymnodinium brevis* Davis, periodically 'bloomed', discolored the water, and resulted in 'fish kills'. The term has been in widespread use for the past eight years and it is now used for nearly all biological phenomena resulting in the discoloration of waters even if 'fish kills' do not occur.

Among the micro-organisms responsible for 'blooms' are bacteria, diatoms, algae, flagellates, ciliates, chaetognaths, and certain crustacea. These 'blooms' occur all over the world in both fresh water and in salt water, and the discoloration caused may acquire brown, yellow, greenish-yellow, green, blue-green, amber, red, or other hues. A variety of terms has been given to discolored waters including 'red water', 'bloody water', 'red plague', 'yellow water', 'stagnant water', 'rotten water', and 'poisoned water'.

Gymnodinium brevis, an unarmored dinoflagellate, has been incriminated by its association with Red Tides in lower Florida west coast waters. In a number of cases since 1946 'blooms' of *G. brevis* have been associated with catastrophic mass mortality of marine organisms. Ray (personal communication) has grown *G. brevis* in bacteria-free cultures and using these cultures he has killed fishes experimentally in aquaria where the bacterial count remained low. Howell (1951) identified *Gonyaulax monilata* sp. nov., an armored dinoflagellate, as the causative agent of a Red Tide on the east coast of Florida during August-September, 1951. A minor fish-kill was associated with this Red Tide. Bein (1954) described *Flavobacterium piscicida* sp. nov., a chromogenic bacterium, from a fish-kill in Florida waters in which a dinoflagel-

Figure 1. Map showing 'Red Tide' occurrences in the coastal waters of southern Florida.

LEGEND

A — *Acartia* sp.
B — *Gymnodinium brevis* Davis
C — *Coscinodiscus* sp.
F — *Ceratium furca* (Ehrenberg)
G — *Gonyaulax* sp.
H — *Rhizosolenia* spp.
M — *Gonyaulax monilata* Howell
P — *Flavobacterium piscicida* Bein
R — Purple Water caused by bacteria
S — *Skujaella* sp.

late bloom was not present. At Ballast Point in Hillsborough Bay south of Tampa, Florida, a minor Red Tide occurred periodically during 1955. Fishes did not seem to be harmed as minnows *(Gambusia)* and mullet *(Mugil)* were seen swimming through the streaked areas from time to time. However, shrimp in bait-wells located on the fishing pier at Ballast Point died when this water was pumped into the wells although good water circulation was maintained. A dinoflagellate, *Ceratium furca* (Ehrenberg), was the predominate organism in the waters examined and counts as high as 17,600,000 cells per liter were observed.

In addition to the dinoflagellates *Gymnodinium brevis* and *Ceratium furca*, the author has observed other blooms along the west coast of Florida. An unidentified species of *Gonyaulax* was observed on several occasions in water samples from Sarasota Bay near Longboat Key. Blooms of a chromogenic bacterium causing 'purple water' were observed near shore at a number of places along Florida's west coast. In one case water with a peculiar greenish-yellow color was found to contain large numbers of a species of *Acartia*. *Skujaella* sp., an alga belonging to the Myxophyceae, commonly blooms in the marine waters of the lower Florida west coast. During the months of June through August, *Rhizosolenia* spp. has been observed in bloom proportions along the lower east coast of Florida by the author. These blooms discolored the water but did not appear to be harmful to other marine life. Lackey (1955) reported a bloom of the diatom *Coscinodiscus* in the area around the mouth of the Myakka River in 1953.

Hayes and Austin (1951) have stated that discolored waters frequently resemble shoals. For this reason the knowledge of where discolored waters occur and the causative agents of these waters is important to the navigator.

The author is indebted to Mrs. Bonnie Eldred for preparing the map shown in Figure 1, and to Mr. Robert M. Ingle for reading the paper in manuscript and offering valuable comments.

AGASSIZ, ALEXANDER. 1890. The topography of Florida. By N. S. Shaler. With a note by Alexander Agassiz. *Bull. Mus. Comp. Zool. Harv., 16*(7): 139-158.

p. 158. ". . . To the damming up of the waters in the Everglades, and to the sudden outbursts of gigantic masses of water charged with organic matter and lime, we may trace the immense destruction of fishes which so frequently occurs on the shores of the Florida keys and the waters surrounding them."

ANONYMOUS. 1881. Mortality of fish in the Gulf of Mexico. *Ann. Mag. Nat. Hist.*, Ser. 5, *8:* 238-240.

This article contains excerpts of a letter by M. A. Moore, writing on November 30, 1880, from Braidentown, Manatee County, Florida, to Prof. S. F. Baird. Moore reports fish being killed by poisoned water. He states that the poisoned waters seemed to be more localized around the mouth of Charlotte Harbor and off Punta Rassa than elsewhere. Bottom fish seemed to be more commonly affected. He believes that water conditions are caused by some sort of volcanic action at the bottom. Also, this article contains a summary of the work which is reported by Endlich (1882).

ANONYMOUS. 1883. Poisoned water in the Gulf of Mexico. *Bull. U. S. Fish Comm., 2:* 104. (From the Sunland Tribune, Tampa, July 20, 1882.)

"We learn from Capt. William Jackson, of the steamer 'Lizzie Henderson', that on his trip from Cedar Key, Tuesday, he encountered a streak of poisoned water, covered with all varieties of dead fish, of more than a mile in extent, off Indian Pass, between Clear Water and Egmont Light. The captain says that a very offensive smell arose from it, and that a good many bottom fish, such as eels, were floating dead on the surface. We opine that this fact upsets the theory of some as to this poisoned water being fresh water from overflow on the mainland, impregnated with poisoned vegetable matter, as there are no streams of any size flowing into the Gulf near where these fish were found."

ANONYMOUS. 1885. Report of the commissioner. *Rep. U. S. Comm. Fish.*, Part II: 68-69.

The probable reason for the rapidly diminishing fisheries in the Gulf of Mexico are given.

p. 69. ". . . probably partly overfishing in particular localities, and partly the numerous pestilences and mortalities by which so many are exterminated. No satisfactory theory has been presented for this mortality, although an intelligent writer suggests that it is due to the influx of the cold water found near the sea bottom at great depth even in the Gulf Stream, which has the same effect as the northers on the coast of Texas during the winter-time."

ANONYMOUS. 1947. Red tide and fish mortality on the Florida west coast. *Marine Laboratory, University of Miami,* Spec. Serv. Bull. No. 1: 1-9. (Mimeographed)

A preliminary discussion of the red tide problem in Florida waters.

ANONYMOUS. 1953. Factors in "red tide" outbreak of 1952. *Progr. Fish Cult., 15*(3): 128.

"While processing data collected during the November 1952 outbreak of 'red tide' off the coast of Florida, the Gulf Fishery Investigations of the U. S. Fish and Wildlife Service found good evidence that effluents of the Caloosahatchee River are important agents in such blooms. It has been noted that activity of this type is probably due to organic content as well as to physical attributes. Experimental work in tanks has indicated that high light intensity, vitamin B_{12}, and sulfides are some of the requirements for mass growth of dinoflagellates as well as other organisms.

"Chemical analyses that have been made by the Geochemistry and Petrology Branch, U. S. Geological Survey, show that significant quantities of titanium and zirconium were present in the 'red tide' bloom water—and not in other waters such as Lake Okeechobee, the surface of Sigsbee Deep, and the tidal lagoon at Galveston."

ANONYMOUS. 1955. Red tide bacteria studies. *Sth. Fisherman, 15*(1): 16 & 58.

A popular account of the bacterial studies being carried out in connection with Florida's red tides.

BAUGHMAN, J. L. 1947. *An Annotated Bibliography of Oysters with Pertinent Material on Mussels and other Shellfish and an Appendix on Pollution.* Tex. A & M Research Foundation, 794 pp.

This work contains a number of references on the red tides of Florida.

BEIN, SELWYN JACK. 1954. A study of certain chromogenic bacteria isolated from "red tide" water with a description of a new species. *Bull. Mar. Sci. Gulf and Caribbean, 4(2):* 110-119.

"ABSTRACT. Experiments performed with a chromogenic bacterium designated as *Flavobacterium piscicida* (sp. nov.) indicates that this organism in pure culture is capable of killing certain fishes under laboratory conditions. This organism was isolated from a fish kill in which no dinoflagellate bloom was present. Similar bacteria have been isolated from Red Tide outbreaks attributed to *Gymnodinium brevis* and from *G. brevis* cultures at the Marine Laboratory and indicates the possibility that a bacterium may be associated with fish deaths under natural conditions. Further investigation is warranted as to the possible relationship of bacteria and dinoflagellates in causing the phenomenon known as 'Red Tide'."

BEIN, SELWYN JACK. 1955. Red tide bacterial studies. *Marine Laboratory, University of Miami,* Special Service Bulletin No. 10. Pp. 1-2. (Mimeographed)

p. 2. "The conclusions drawn from these experiments are as follows: The fish are killed by a water soluble, toxic material, *produced by the growth of the bacteria.* The toxin is thermolabile, that is, unstable at high temperatures, but extremely poisonous under natural climatic conditions. Given the correct conditions these organisms appear capable of 'blooming' and causing mass mortality of marine organisms in nature."

BRICE, JOHN J. 1898. 6.-The fish and fiisheries of the coastal waters of Florida. *Rep. U. S. Comm. Fish.,* Part 22: 263-342.

One theory as to the cause of sponge deaths is that poisonous waters come out of some of the Florida west coast rivers and kills them.

BRONGERSMA-SANDERS, MARGARETHA. 1948. The importance of upwelling water to vertebrate paleontology and oil geology. *Kon. Ned. Ak. Wet., Verh. Afd. Nat.* (Tweede Sectie), *45*(4): 1-112.

This work contains a section dealing with mortality of marine animals along the coast of Florida.

CARLSON, Y. A. 1908. Brilliant Gulf waters. *Monthly Weather Review, 36:* 371-372.

Streaks of brilliantly-hued (luminescent) waters were encountered in the Gulf of Mexico. No mention of "red" water or fish-kills was made.

CHEW, FRANK. 1953. Results of hydrographic and chemical investigations in the region of the "red tide" bloom on the west coast of Florida in November 1952. *Bull. Mar. Sci. Gulf and Caribbean, 2*(4): 610-625.

"ABSTRACT. Eleven hydrographic stations were occupied in the *Gymnodinium* bloom area off Fort Myers, Florida, in November 1952. These data provide the basis for a three-dimensional description of the hydrographic environment where the phenomenon occurred.

"The current pattern in the area of study was more complex than is generally thought. There was eddying motion which appears to be seasonal in character.

"Regions of maximum total phosphorus were found to coincide with water of Gulf origin, while water with greater river influence contained regions of minimum total phosphorus. This pattern implies that the increased phosphorus content probably came from the open Gulf.

"The total phosphorus changed slowly with depth in a slanting water column, and areas of definite *Gymnodinium* bloom, while high in total phosphorus, did not coincide with areas of maximum observed total phosphorus which was some ten times the normal value.

"Three mechanisms capable of effecting the observed total phosphorus pattern are given. No proven explanation of the causes of the recurrent plankton blooms is as yet available."

CHEW, FRANK. 1955. On the offshore circulation and a convergence mechanism in the red tide region off the west coast of Florida, *Marine Laboratory, University of Miami* (Report to Florida State Board of Conservation). Pp. 1-26. (Mimeographed)

"ABSTRACT. The offshore water is shown to move as a single column. The sloping bottom and the equation of continuity are then applied to show the existence of a horizontal convergence mechanism which, over a period of several weeks, may effect an increase in concentration of floating particles some several times its initial value. The southbound current in the 'loop' is thought of as a Rossby jet which drives the cyclonic eddy offshore. Consideration of the abbreviated verticity equation, together with the fact of sloping bottom, show that the southeastern quadrant of the cyclonic eddy possesses increasing negative vorticity and hence the organisms previously concentrated will tend to wash ashore. Some consideration of the effects of wind are also included."

CHEW, FRANK. 1955. The summer circulation of the Florida west coast offshore water as deduced from the pattern of thermocline depths and a nongeostrophic equation of motion. *Marine Laboratory, University of Miami* (Report to Florida State Board of Conservation). Pp. 1-6. (Mimeographed) Also: *Trans. Amer. Geophysics Union, 36*(6): 963-974.

"ABSTRACT. On the basis of the pattern of thermocline depths as read from Bathythermograms and a non-geostrophic but steady state equation of motion, the circulation of the water off the Florida west coast is deduced. This circulation agrees with that found previously on the basis of horizontal salinity patterns. Since salinity and Bathythermograph measurements were made by independent tools, the agreement is significant."

CHEW, FRANK. 1955. Red tide and the fluctuation of conservative concentrations at an estuarine mouth. *Bull. Mar. Sci. Gulf and Caribbean, 5*(4): 321-330.

"ABSTRACT. A set of observations of the conservative concentration, salinity, at an estuary mouth in a Red Tide region is generalized by an extension of the mixing length theory of tidal flushing for steady state to one for transient state. The river flow and tidal current are taken as functions of time, but not of space. The solution confirms the expectation that the intensity of the zone of rapid transition of conservative concentrations is greatest during high river flow and low tidal ranges. The solution also indicates that the tidal advection and diffusion reinforce each other."

COLLIER, ALBERT. 1953. Titanium and zirconium in bloom of *Gymnodinium brevis* Davis. *Science, 118*(3064): 329.

"As a result of the analysis, it was found that titanium was peculiar to the red-tide water at a concentration of 0.01-0.1% of total solids (33,700 ppm), and zirconium at 0.001-0.01% total solids (33,700 ppm). These elements did not appear in the other samples.

"The largest contributor to the nonoceanic component of the neritic waters of the Sanibel Island region is Lake Okeechobee and the analysis of this water showed the presence of Ca, Na, Mg, Si, Sr, K, Al, Sn, Fe, Ba, Ni, B, Pb, Cu, Mn, Cr, and Ag, but not Ti and Zr. It is likely that Ti and Zr are normally present in the sea water in traces beyond the sensitivity of the analytical method, but in this case were concentrated by the organisms of the mass bloom. The standard sensitivities given for the spectrographic

method (semi-quantitative) are for zirconium 0.001%, and for titanium 0.001%.

"These elements will be studied as nutritional trace elements in the cultural studies of dinoflagellates now in progress in this laboratory."

COLLIER, ALBERT. 1953. The significance of organic compounds in sea water. *Trans. 18th N. Amer. Wildl. Conf.*, pp. 463-472.

"SUMMARY. That sea water contains a significant quantity of dissolved organic compounds is a long recognized fact. More recently, biological differences between waters have been proven and their effects on the survival of invertebrate larvae demonstrated. It has been shown that substances which may originate in the photosynthetic process have a direct and quantitative influence on the feeding rate of oysters.

"In the laboratories of the Gulf Fishery Investigations of the U. S. Fish and Wildlife Service carbohydrate and proteinaceous substances are being isolated and purified for experimental testing on living organisms, including young fish and dinoflagellates.

"The principal fields of possible significance of these compounds are: as an energy source; as regulators or stimulators of feeding activities; effects on movements of marine animals; toxins; and in the evaluation of the biological activity within discrete bodies of water."

COLLIER, ALBERT. 1955. Newsletter on red tide research. *U. S. Fish and Wildl. Serv.* (April). Pp. 1-2. (Mimeographed)

A small bloom of *Gymnodinium brevis* was created in the laboratory. At concentrations of 3,000,000 individuals per liter cultures of this organism were used to kill fish experimentally. It was reported that bacteria-free cultures of *G. brevis* were being maintained in the laboratory.

COLLIER, ALBERT W., and KENNETH T. MARVIN. 1953. Stabilization of the phosphate ratio of sea water by freezing. *Fish. Bull., U. S., 54*(79): 71-76.

This reference has been included since phosphorus has been suggested as being a possible limiting factor in the case of Red Tide blooms.

COLLINS, J. W. 1887. XIV.-Report on the discovery and investigation of fishing-grounds, made by the Fish Commission Steamer 'Albatross' during a cruise along the Atlantic coast and in the Gulf of Mexico; with notes on the Gulf fisheries. *Rep. U. S. Comm. Fish.*, Part 13: 217-311.

This report mentions 'poisoned water' along the Florida coast. The water was said to seriously affect marine life, including sponges. Ingersoll (1882) is cited. According to Collins (p. 249): "Mr. Silas Stearns, who has had exceptional opportunities for becoming familiar with the subject which Mr. Ingersoll refers to, is authority for stating that the sponge fishery about Anclote Keys was not to any appreciable extent injuriously affected by the poisonous water. He was there in 1878, 1879, and 1880: part of the time employed as an expert by the United States Government to investigate the fisheries of western Florida and collect statistics of them for the Tenth Census. On one occasion he took a boat-load of sponges himself near Anclote, in 2 fathoms of water, a feat that pretty effectually settled the question as to whether the sponges were all destroyed in this region."

CORNMAN, IVOR. 1947. Retardation of *Arbacia* egg cleavage by dinoflagellate-contaminated sea water (red tide). *Biol. Bull., Woods Hole,* 93(2): 205.

"ABSTRACT. Two specimens of 'red tide' were generously supplied by Dr. P. S. Galtsoff, Director of the U. S. Fisheries Laboratory, Woods Hole, Massachusetts.

"An untreated decomposing sample of sea water taken from an area stained red by *Gymnodinium* when diluted 1:10 retarded *Arbacia*

egg cleavage by one hour—100 percent increase in cleavage time—if added 10 minutes after fertilization. When most of the H_2S was pulled off with a vacuum pump, the delay at 1:10 was only 3 minutes and at 1:5 was 15 minutes. Four days later all odor of H_2S was gone, but retardation was essentially the same, 9 percent at 1:10 and 27 percent at 1:5. Cytolysis resulted from exposure to 1:2. This inhibitory potency is equal to that of crude filtrate from some *Penicillium* cultures. This sea water sample killed *Fundulus* in 2 hours at 1:2 and in 5½ hours at 1:10. A 'red tide' plankton sample suspended in sea water and preserved with $CHCl_3$ was evacuated until no odor of $CHCl_3$ remained. At 1:10 this retarded cleavage 10 minutes. *Fundulus* in this sample diluted with an equal part of sea water lost equilibrium and became sluggish in 2 hours, and in 6 hours at 1:10. They recovered motility in fresh sea water, but subsequently died. There appears to be some parallel between the toxicity to fish and to dividing eggs, but whether the same poison acts upon both and whether decomposition plays an important role remain to be determined. Studies conducted near the site with fresh samples of sea water and dinoflagellates should prove more helpful if uncontaiminated test organisms are available."

DAVIS, CHARLES C. 1948. *Gymnodinium brevis* sp. nov., a cause of discolored water and animal mortality in the Gulf of Mexico. *Bot. Gaz., 109*(3): 358-360.

Along the lower Florida west coast in 1947, a species of the genus *Gymnodinium* was found associated with a yellowish-green discoloration of water and mortality of marine animals. This dinoflagellate was enormously abundant, occuring in numbers as high as 60,000,000 per liter. This organism appeared to be new to science. It was described under the name *Gymnodinium brevis.*

DAVIS, CHARLES C. 1949(1950). Observations of plankton taken in marine waters of Florida in 1947 and 1948. *Quart. J. Fla. Acad. Sci., 12*(2): 67-103.

Dinoflagellates were shown to dominate the plankton of certain samples taken during a period of Red Tide.

DELANY, M. 1956. Cultivation of a presumably autotrophic dinoflagellate. *Amer. Midl. Nat. (in press)*

EMERSON, D. L. 1948. Preliminary survery on the Florida red tide phenomenon. *Marine Laboratory, University of Miami.* Pp. 1-2. (Mimeographed)

Red tide is said to have occurred along the west coast of Florida in 1844; 1854; 1878; 1880; 1882; 1908; 1916; from November, 1946, to March, 1947; and in July and August, 1947. 'Plankton blooming' is discussed; it is stated that 'blooming' does not always cause mortality of marine animals.

P. 2. "Various hypotheses have been advanced to account for the red tide phenomena. Some early observers believed the disaster to be due to an underwater eruption of poisonous springs released by earthquakes, to the leaching of poisonous substances by streams, and in the past occurrence to the dumping of poisonous gases, chemicals, and other war munitions into the Gulf as a method of disposal. These appear to be groundless suppositions and have since been disregarded."

A program for work on red tide is suggested.

ENDLICH, F. M. 1882. An analysis of water destructive to fish in the Gulf of Mexico. *Proc. U. S. Nat. Mus., 4:* 124.

A report in the form of a letter on the analysis of two samples of Gulf water, (A) in which fish die, and (B) normal, or good water.

The author's findings were:

		A.		B.
"Specific gravity		1.024		1.022
Solid constituents (total), percent		4.0780		4.1095
Ferric compounds, percent		0.1106		0.0724
Injurious organic matter	ratio	= 3	=	2"

Also: "In my estimation the death of fish was caused by the more or less parasitic algae, which was found in large quantities in water A, but do not occur at all in water B."

FARLOW, W. G., Dr. 1882. Report on the contents of two bottles of water from the Gulf of Mexico, forwarded by the Smithsonian Institution. *Proc. U. S. Nat Mus., 4*: 234.

The contents of the bottles were alike and the major portion of the contents was "a mass of amorphous slime". Evidently a preservative was not used in either bottle.

FIENSTEIN, ANITA, A. RUSSELL CEURVELS, ROBERT F. HUTTON and EDWARD SNOEK. 1955. Red tide outbreaks off the Florida west coast. *Marine Laboratory, University of Miami* (Report to the Florida State Board of Conservation). Pp. 1-44. (Mineographed)

"ABSTRACT. A compilation of reports of Red Tide on the west coast of Florida from 1844 to January, 1955, is given. Also included are two working diagrams of incidence of Red Tide, suggesting that (1) Red Tide occurs more frequently in the months August through January, (2) the individual Red Tide outbreaks are part of larger outbreaks which seem to move from south to north, and (3) summer outbreaks appear to originate mostly north of Venice, winter and spring outbreaks farther south. Further data are required to give complete support to (2). If this is substantiated, it is pointed out that control may be exerted by action in a limited focal area or areas of origin. Otherwise the problem of control may be of the greatest difficulty since it will require action over a much wider area or areas."

FISH, CHARLES J., and MARY CURTIS COBB. 1954. Noxious marine animals of the central and western Pacific Ocean. *U. S. Fish and Wildl. Serv.*, Research Report 36: 1-45.

This work contains a number of references on toxic plankton including some on Florida's red tide problem.

FLORIDA STATE BOARD OF CONSERVATION. 1949. Eighth Biennial Report (1947-48). Pp. 1-39.

The red tide outbreaks of 1946-47 and the scientific research carried out on these outbreaks are discussed.

FLORIDA STATE BOARD OF CONSERVATION. 1950. Ninth Biennial Report (1949-50). Pp. 1-61.

A brief mention of Florida red tide research is made.

FLORIDA STATE BOARD OF CONSERVATION. 1953. Tenth Biennial Report (1951-52). Pp. 1-66.

p. 49. "Several investigations were made of fish deaths due to pollution, notably in the Miami River and at Ft. Lauderdale. Reduced oxygen content of the water was found to be responsible in all cases.

"Late in 1952 an outbreak of Red Tide occured on the Florida West Coast. A team of biologists and hydrographers gathered data on this, employing an airplane and a chartered vessel which was equipped with portable oceanographic equipment. A series of hydrographic stations was made across two principal areas of the outbreak. The organism was found to be the same as the one responsible for the serious Red Tide of 1947,

Gymnodinium brevis. Cultures of the organism have been established and are growing in the laboratory.

"The 1952 outbreak was not as serious as that of 1947, but at the time that this report was prepared (January 1953), Red Tide was still present.

"Analysis of the data collected will attempt to correlate hydrographic conditions with the blooms of the Red Tide organism, to increase our understanding of this serious phenomenon."

FLORIDA STATE BOARD OF CONSERVATION. 1955. Eleventh Biennial Report (1953-54). Pp. 1-43.

A review of the scientific research being carried out in Florida waters is included.

GALTSOFF, PAUL S. 1948. Red tide. Progress on the investigations of the cause of mortality of fish along the west coast of Florida conducted by the Fish and Wildlife Service and cooperating organizations. *Spec. Sci. Rep. U. S. Fish Wildl. Serv.,* (46): 1-44.

The literature on the blooming of aquatic micro-organisms is reviewed briefly. The Florida red tide is discussed and the characteristics and effects of red water are reported. The color of the water in which fish had died was reported as green, greenish yellow, yellow, amber, brown, reddish, and red. One of the predominant organisms was *Gymnodinium* which varied from 13,000,000 to 56,000,000 per liter. The total phosphorus was "from 5 to 10 times as high as those ever encountered in uncontaminated oceanic water." An odorless, irritating gas, associated with onshore winds and breaking of the surf, was described. "It caused spasmic coughing, a burning sensation in the throat and nostrils, and irritation of the eyes." Control measures are discussed, but "no definite recommendation for control can be made at present." Economic losses are mentioned and conclusions are stated.

GALTSOFF, PAUL S. 1949. The mystery of the red tide. *Sci. Mon., N. Y.,* 58(2): 109-117.

Contains essentially the same information as Galtsoff (1948).

GEYER, RICHARD A. 1950. A bibliography on the Gulf of Mexico. *Tex. J. Sci.,* 2(1): 44-93.

In Appendix A and Appendix B this work includes references on mass mortality of aquatic organisms in various parts of the world.

GILL, THEODORE. 1883. Zoology. *Ann. Rep. Board of Regents of the Smithsonian Inst., showing the operations, expenditures and condition of the Inst. for the year 1881:* 465-467.

A report on "fish epidemics" in the Gulf of Mexico, including a list of references published in the *Proc. U. S. Nat. Mus.*

GLAZIER, W. C. W. 1882. On the destruction of fish by polluted waters in the Gulf of Mexico. *Proc. U. S. Nat. Mus., 4:* 126-127.

A report of colored water in which fish died during about 1865 and in 1878 and 1880. The 1880 mortality occurred in the waters of Tampa, Sarasota, and Charlotte Harbor.

GLENNAN, A. H. 1887. 4.-Fish killed by piosonous water. *Bull. U. S. Fish Comm., 6:* 10-11.

A report of fish killed by 'poisoned water' of a reddish color during October, 1885. Large shoals of dead fish were reported between Egmont Key Light and Charlotte Harbor. Also reported was "that in some of the freshwater creeks fish are caught by placing bags of the bruised bark of the swamp dogwood (*Cornus sericea*) in still water, and that the fish will revive if allowed to remain in it for a short time only." (p. 11)

GRAHAM, HERBERT W. 1954. Dinoflagellates of the Gulf of Mexico. In "Gulf of Mexico. Its origin, water, and marine life." *Fishery Bulletin of the U. S. Fish and Wildlife Service*, 55(89): 223-226.

The dinoflagellate plankton along the west coast of Florida is mentioned in connection with the red tide.

GRAHAM, HERBERT W., JOHN M. AMISON and KENNETH T. MARVIN. 1954. Phosphorus content of waters along the west coast of Florida. *Spec. Sci. Rep. U. S. Fish Wildl. Serv.*, (122): 1-43.

"ABSTRACT. The distribution of inorganic and total phosphorus in the waters along the west coast of Florida is reported for a period of more than 16 months. Some upwelling to subsurface levels is evident but no hydrographic feature occurs which could account for the high values of phosphorus found during the 'red tide' of 1946-47. There is no evidence that either leaching from the bottom of the Gulf or outflow from local rivers contributes large quantities of phosphorus to the Gulf waters. However, values of total phosphorus comparable to those of the red tide were found in blooms of *Trichodesmium* floating on the surface over water of very low phosphorus content."

GUNTER, GORDON. 1947. Catastrophism in the sea and its paleontological significance, with special reference to the Gulf of Mexico. *Amer. J. Sci.* *245*(11): 669-676.

"ABSTRACT. The importance of catastrophism and mass mortality in paleontology has been emphasized by certain recent writers. On the Gulf Coast of the United States mass mortalities of marine animals of shallow water, catastrophic in nature, are brought about every ten years or so by hard cold spells, plankton blooms, and excessively high salinities; the latter case being confined to the Laguna Madre of Texas. The vastness of the mortality, which may cover several hundred square miles, low temperatures, high salinity and silting due to high winds or heavy drainage from land, which may accompany the mortalities in various combinations, are conditions prejudicial to fossilization. Such events may occur thousands of times in a million years. Catastrophic mass mortalities of marine animals in the Gulf of Mexico are important factors in fossilization of the fauna of that region."

GUNTER, GORDON. 1949. The "red tide" and the Florida fisheries. *Proc. Gulf and Caribbean Fish. Inst.*, Inaugural Session: 31-32.

A review of Florida's red tide problem.

GUNTER, GORDON, F. G. WALTON SMITH, and ROBERT H. WILLIAMS. 1947. Mass mortality of marine animals on the lower west coast of Florida, November 1946 - January 1947. *Science, 105*(2723): 256-257.

During November, 1946, dead and dying fish and turtles were observed in the marine waters 10-14 miles offshore from Naples. By January 10, 1947, the mortality had reached northward to Boca Grande and fish were still dying in the bays behind Captiva and Sanibel Islands on January 29. The critical area for this mortality was from Dry Tortugas to Boca Grande. It was estimated that over 50,000,000 fish were killed in the area. All kinds of fish, oysters, clams, crabs, shrimp, barnacles and coquinas were killed. A species of *Gymnodinium* was observed in some of the waters. Salinities were observed to be normal, temperatures ranged from 22.5° C. to 26° C., pH was around 8.2, and dissolved oxygen, with one exception, was not low. Although hydrogen sulfide was reported earlier at Naples the writers could not detect any during their investigation. An odorless irritant 'gas' was reported on the Gulf Beach of Captiva Island from January 22 to 26.

GUNTER, GORDON, ROBERT H. WILLIAMS, CHARLES C. DAVIS, and F. G. WALTON SMITH. 1948. Catastrophic mass mortality of marine animals and coincident phytoplankton bloom on the west coast of Florida, November 1946 to August 1947. *Ecol. Monogr. 18*(3): 309-324.

"SUMMARY. 1. A mortality of marine fishes and other animals of catastrophic proportions took place along the lower West Florida coast between November, 1946, and August, 1947.

"2. In isolated places, and not in regular association with dying fish, low oxygen tension was found. This may have been associated with the decay of large numbers of dead animals and is to be considered a result rather than a cause of the mortality. The chemistry of the sea water was not found to be abnormal.

"3. The mass death of marine organisms was associated with the flowering of dinoflagellate, *Gymnodinium brevis.* Water that contained this organism killed fishes in an aerated aquarium and fishes were found dying in its presence in the sea, although the oxygen content was high. In some places *Gymnodinium brevis* reproduced so abundantly that patches of the water became saffron yellow in color and noticeably viscous. Schools of fishes entering this water died immediately. It is concluded that *Gymnodinium brevis,* like certain related dinoflagellates, is specifically poisonous to marine animals when present in large numbers.

"4. The weather was abnormally warm and still and a hurricane wind blew offshore on the lower Florida Gulf Coast during the fall of 1946. It is suggested that changed meteorological conditions or other factors may have brought about changes of the water masses which increased the supplies of nutrient salts and led to a flowering of the plankton, especially *Gymnodinium brevis.* The more remote possibility of seismic disturbances is also considered together with the possibility of causative factors other than an increase of nutrient salts.

"5. Records of similar catastrophic mortalities localized along the lower West Coast go back to 1844, and it is suggested that these instances had similar causes.

"6. Fishes found dead along the beaches show that the families of fishes of greatest abundance in lower Florida are quite different from those of the northern Gulf Coast and a transition from a temperate to a tropical fauna is indicated."

HAYES, HELAN LANDAU, and THOMAS S. AUSTIN. 1951. The distribution of discolored sea water. *Tex. J. Sci., 3*(4): 530-541.

This work contains a number of references on the red tides of Florida.

HELA, ILMO. 1955. Ecological observations on a locally limited red tide bloom. *Bull. Mar. Sci. Gulf and Caribbean, 5*(4): 269-291.

"ABSTRACT. In order to study the assumed importance of the passes in generating Red Tide outbreaks, the hydrographical tidal conditions were studied in the Boca Grande Pass. The results confirmed previous ones and indicated the two-layer character of this estuary. In the deeper water no *Gymnodinium brevis* was found. The heavier concentration was observed during all tidal phases on the side of Gasparilla Island, suggesting that they must have originated somewhere 'behind Gasparilla Island' and not in the area of the highest total phosphorus. As a second, simultaneous part of the study, an effort was made to find the areas from which the *G. brevis* in this case originated. In two separate spots (Stations 12 and 20) actual, locally limited Red Tide kills were observed. An optimum salinity for the *G. brevis* appeared to exist between 32 and 33 parts per thousand. A diurnal vertical migration of *G. brevis* was observed."

HELA, ILMO. 1956. A pattern of coastal circulation inferred from synoptic salinity data. *Bull. Mar. Sci. Gulf and Caribbean, 6*(1): 74-83.

"ABSTRACT. A synoptic operation was performed during the forenoon and noon hours on December 4, 1954 when 28 vessels occupied 250 limited hydrographic stations off the west coast of Florida. The salinity distributions are shown for the surface and for 40 feet. The pattern of coastal circulation is referred to the cyclonic eddy off the Florida west coast. Two major indrafts of high salinity water toward the shoreline are found. The mechanics of this phenomenon, and also the permanency of the observed pattern are discussed."

HELA, ILMO, DONALD DE SYLVA, and CLARENCE A. CARPENTER. 1955. Drift currents in the red tide area of the easternmost region of the Gulf of Mexico. *Marine Laboratory, University of Miami.* Pp. 1-31. (Mimeographed)

"ABSTRACT. During 1954 two driftcard operations were performed in the easternmost shallow region of the Gulf of Mexico. Given the locations and times of the drops and of their recovery, the direction and speed of the resultant movement of the driftcards may be deduced with relative accuracy, provided that one takes into consideration only those cards which are found either afloat offshore or those which, if picked up ashore, are found soon after their landing.

"These operations were performed as a part of the Red Tide studies for the Florida State Board of Conservation . . ."

HOWELL, JOHN F. 1953. *Gonyaulax monilata* sp. nov., the causative dinoflagellate of a red tide on the east coast of Florida in August-September, 1951. *Trans. Amer. Micr. Soc.,* 72(2): 153-156.

This species was reported from the Indian and Banana Rivers, Florida, and from City Pier, Sarasota, Florida. An additional note states that a chain-forming dinoflagellate, with the plates identical to those of *Gonyaulax monilata*, occurred in a sample from Offatts Bayou, Texas.

INGERSOLL, ERNEST. 1882. On the fish-mortality in the Gulf of Mexico. *Proc. U. S. Nat. Mus., 4:* 74-80.

An investigation into the so-called "poisoned water" problem. According to this author, mortality occurred in 1844 when there was "widespread destruction of all sorts of salt-water animal life . . ."

p. 75. "Again, in 1854 the fishes suffered all along the southern shore, and have done so at intervals since to a less degree, until in 1878 an excessive fatality spread among them, which was wider in the extent of its damaging effects and probably more destructive in point of number of victims than the latter visitation of 1880. Even the cooler half of 1879 was not exempt from some appearance of the plague."

p. 75-76. "Concerning the attack of 1880 I am able to say more. It began suddenly, and immediately followed the terrible hurricane which is known as the 'August gale', the fish and all other ocean life suddenly dying in hordes all along the southern (eastern) shore of Tampa Bay, on Egmont Key, at its mouth, which was the most northern point, and thence southward as far as Shark River, in Whitewater Bay, on the coast."

p. 78. "In the pure element, between the deadly streaks, fish were as abundant as ever at the distance from the coast where the smacks operated, and their wells were often filled with promptness; but it was found that it was impossible, even by going straight out to the Tortugas, to run the gauntlet of the poisoned water floating between there and Cape Sable, since if once it was encountered, and entered the well, a very few minutes sufficed to bring about the death of every fin of the cargo. I have a few notes, culled from the Key West journals, which show that a loss of nearly $10,000 resulted from only four or five such misfortunes. The consequence was that for some weeks the

fishing throughout all that part of the Gulf had to be wholly abandoned, involving the idleness of a large number of vessels and their crews."

p. 79. "It was the death of sponges, conchs, sea-anemones, crawling horseshoe-crabs, of toad-fish, skates, and the like, which keep close down on the bottom, that first apprised the fishermen of the presence of their dreaded and mysterious enemy."

INGLE, ROBERT M. 1954. Irritant gases associated with red tide. *Marine Laboratory, University of Miami,* Spec. Serv. Bull. No. 9: 1-4.

"SUMMARY. 1. Irritant effects to the nose and throat associated with red tides are temporary. No after-effects have been reported.

"2. Irritant effects are present only when red tide occurs and even then do not appear unless wind-driven waves with associated water vapor and droplets exist. Naturally, on some occasions, droplets will remain in suspension in the air for a short time after the wind that created them has subsided.

"3. Because irritant exists probably either as particles or droplets carried by wind then thrown into the air by spray, it does not usually go far inland beyond open beaches.

"4. There is no evidence that the irritating effects are caused by a military gas or any other man-made product."

INGLE, ROBERT M., and DONALD P. DE SYLVA. 1955. The red tide. *Marine Laboratory, University of Miami,* Ed. Ser. 1: 1-30.

"SUMMARY. 1. The Florida Red Tide is caused by microscopic organisms. Normally present in sea water along the lower Florida west coast in small numbers, they may suddenly reproduce to form many billions of individuals. The water is characteristically discolored. At certain times these organisms become numerous enough to kill many thousands of marine animals.

"2. Since 1844 the Florida Red Tide has occurred at least 13 times in major proportions. There are apparently gaps of as much as fourteen years when no Red Tides have been reported.

"3. When the Red Tide appears, a slightly irritating gas may be noticed. No evidence exists that this gas is due to a dumping of scrap war-material, or other man-made products, into the coastal waters. Much scientific evidence links the gas with the Red Tide organism. The effects of the gas are restricted to the sea or beach areas and are temporary. The slight coughing sensations disappear when the Red Tide diminishes.

"4. Fish not killed or whose behavior is not noticeably affected by Red Tide are apparently safe for human consumption, according to all available information.

"5. The riddle of the Red Tide has been under continuous study by a team of trained marine scientists of the Marine Laboratory of the University of Miami since 1947. The U. S. Fish and Wildlife Service is also engaged in this study. Individuals from the University of Florida, the University of Tampa, and other organizations, have also worked on this problem at various times.

"6. Several theories have been proposed to explain the biological mechanisms that start and maintain Red Tides. Presently, most of these are being investigated. Full-scale, continued research is needed to solve a problem as complicated as Red Tide.

"7. Red Tides which have occurred in other parts of the world since Biblical times were usually associated with some type of water-borne enrichment or fertilization. The high phosphorus content of the soils and offshore bottom of Florida's west coast offers a likely avenue of study, especially since such streams as the Peace River are shown to carry substantial amounts of phosphorus to the Gulf."

JEFFERSON, J. P. 1879. On the mortality of fishes in the Gulf of Mexico in 1878. *Proc. U. S. Nat. Mus., 1*: 363-364.

This publication consists of a letter from J. P. Jefferson, Lieutenant Fifth Regiment Artillery, to Prof. Spencer F. Baird, Smithsonian Institution, Washington, D. C. The letter was written in December, 1878, and describes 'discolored water' moving down along the coast, across Florida Bay, to Tortugas (about November 20) and extending to at least as far as Key West. Dead fish were reported from Fort Jefferson and neighboring keys, the north side of the island of Key West, and about 15 miles out in the Gulf Stream. In Tampa Bay oysters were killed. It was reported that the Caloosahatchee River overflowed its banks in October and the whole country side was flooded.

JEFFERSON, J. P., JOSEPH Y. PORTER, and THOMAS MOORE. 1879. On the destruction of fish in the vicinity of the Tortugas during the months of September and October, 1878. *Proc. U. S. Nat. Mus., 1:* 244-246.

A report, in the form of three letters, of fish dying and conchs being killed by "dark cypress looking water" in the Gulf of Mexico, especially in Florida Bay.

KETCHUM, BOSTWICK H., and JEAN KEEN. 1948. Unusual phosphorus concentrations in the Florida "red tide" sea water. *J. Mar. Res.,* 7(1): 17-21.

"SUMMARY. 1. The total phosphorus content of waters containing dense *Gymnodinium* populations was found to be 2½ to 10 times the maximum to be expected in the sea. The possibility that upwelling of nutrient-rich, deep water is the explanation of this intense plankton bloom is thereby excluded.

"2. It is suggested that future studies of intense plankton blooms include total phosphorus determinations at various depths. The results would differentiate between terrigenous contaminations and swarming of the organisms at the sea surface."

KIERSTEAD, HENRY, and L. BASIL SLOBODKIN. 1953. The size of water masses containing plankton blooms. *J. Mar. Res., 12*(1):141-147.

"ABSTRACT. If a phytoplankton population is assumed to be increasing logarithmically in a mass of water surrounded by water which is unsuitable for the survival of the population, it can be shown that there is a minimum critical size for the water mass below which no increase in concentration of phytoplankton can occur. In a one-dimensional water mass with leakage at both ends, this size, after a time of the order of $L^2/8\ ^2D$, is given by

$$L_c = \sqrt{\frac{D}{K}},$$

where L_c is the length of the water mass, D the diffusion, and K the rate or increase of the population. The corresponding size in a cylindrical water mass is given by

$$R_c = 2.4048$$

where R_c is the radius of the water mass."

KING, GLADYS S. 1950. Production of red tide in the laboratory. *Proc. Gulf and Caribbean Fish. Inst.* (Second Ann. Session): 107-109.

An experimental investigation of the nutritional requirements of a protozon, *Plagicampa marina*, and the dinoflagellate, *Gymnodinium simplex.* This work indicates that the two organisms studied not only are able to utilize certain organic nitrogenous material when disolved in ocean water, but that actually such substances are required in the organisms

nutrition. The work is offered as "a basis for recommending an investigation of dissolved organic nitrogenous matter in Gulf water as a clue to outbursts of Red Tide dinoflagellates."

KING, JOSEPH E. 1949. A preliminary report on the plankton of the west coast of Florida. *Quart. J. Fla. Acad. Sci., 12(2):* 109-137.

In general the purpose of this paper is to identify the planktonic forms, especially the dinoflagellates and copepods, in the waters off the west coast of Florida. There is a brief discussion of red tide and one of the main objectives of the paper is to determine "the normal or typical plankton" which was present during the investigation period of about ten months (January to October, 1949). *Gonyaulax triacantha, Gonyaulax* sp., *Polykrikos* sp. *(schwartzi ?), Cochlodinium* sp. *(virescens ?), Gymnodinium* sp. *(nelsoni ?), Ceratium furca,* and *Dinophysis* sp. were among the dinoflagellates found in a surface sample of "red water".

LACKEY, JAMES B. 1956. Note on the occurrence of *Gymnodinium brevis* in Trinidad waters. *Quart. J. Fla. Acad. Sci., (in press).*

The recorded geographical range of *G. brevis* is extended to the coast of Trinidad.

LACKEY, JAMES B., and JACQUELINE A. HYNES. 1955. The Florida Gulf coast red tide. *Engineering Progress at the University of Florida,* 9(2): 3-23.

"FORWARD. The work detailed in this bulletin represents an attempt to evaluate the effects of *Gymnodinium brevis,* its behavior and its distribution; some investigation of factors which may cause its phenomenal growth and of factors which may help in its control. Our laboratory has not attempted to investigate phases of the problem which are under attack at the University of Miami or at the laboratory of the U. S. Fish and Wildlife Service . . ."

LaCOSSITT, HENRY. 1954. The truth about Florida's red tide. *Sat. Eve. Post, 227*(7): 28-29, 67-68.

A popular account of the red tide. The author visited Bradenton where he experienced irritations of the nose and throat from the so-called "gas".

LASKER, REUBIN and F. G. WALTON SMITH. 1954. Red tide. In "Gulf of Mexico. Its origin, waters, and marine life." *Fish. Bull., U. S. Fish Wild. Serv., 55*(89): 173-176.

A review of Florida's red tide.

LONG, E. JOHN. 1953. The red tide hits and runs. *Nature Mag., 46*(3): 125-128 and 162.

Florida's red tide problem reviewed in a popular article.

MARINE LABORATORY, UNIVERSITY OF MIAMI. 1948. The red tide. *State of Florida, Board of Conservation,* Educ. Ser. No. 1: 1-14.

An educational bulletin on the red tide.

MARINE LABORATORY, UNIVERSITY OF MIAMI. 1948. Report on a survey of the sponge grounds north of Anclote Light. *Florida State Board of Conservation* (January). Pp. 1-6. (Mimeographed)

From "SUMMARY". pp. 1-2. "3. The enormous depletion of the sponge grounds is due to several factors. A lack of proper scientific management and control brought about a slow but continuous drop in production since 1935. The fungus disease of 1939 caused a very considerable mortality which was aggravated by failure to institute

proper control. During 1946 and 1947 a second mortality due to natural causes brought further losses. At the present time no active disease is present in the area north of Anclote Light, and the greater part of the grounds are in a very healthy condition. No sponges were present in the deep water grounds and no new varieties of sponge which could become of commercial value were found."

MARINE LABORATORY, UNIVERSITY OF MIAMI. 1949. Quarterly report on fisheries research. Florida State Board of Conservation (December). Pp. 1-3. (Mimeographed)

p. 2. "Red Tide . . . Certain organisms closely related to the Red Tide dinoflagellate have been successfully cultured in sea water supplemented by yeast extract. Organisms have been in continuous culture in this nutrient for nearly a year, with no sign of diminishing vitality. ". . ."

MARINE LABORATORY, UNIVERSITY OF MIAMI. 1949. Biennial report on the marine fishery research program. *Florida State Board of Conservation* (June). Pp. 1-9. (Mimeographed)

p. 4. "Investigations of the Red Tide were begun during 1947 in behalf of the Board of Conservation, and the microscopic organism responsible for it has been described in reports issued by the Mairne Laboratory since that date. . .

"The research has been continued since October 1948 and numerous chemical samples of the seawater in the Gulf of Mexico have been collected during the sponge surveys. These have been analyzed by oceanographic chemists in an attempt to study the fundamental conditions existing in the Gulf water. A knowledge of this gives some indication of the possible causes of the abnormal chemical conditions which existed in 1948 and were responsible for the growth of Red Tide organism. ". . ."

MARINE LABORATORY, UNIVERSITY OF MIAMI. 1950. Quarterly report on fisheries research. *Florida State Board of Conservation* (October). Pp. 1-7. (Mimeographed)

From "SUMMARY". p. 2. "Productivity and nutrition studies on plankton and a study of the underlying physical and chemical conditions have been carried out as part of a long term program and includes the red tide studies begun in 1947."

MARINE LABORATORY, UNIVERSITY OF MIAMI. 1952. Quarterly report on fisheries research. *Florida State Board of Conservation* (December). Pp. 1-10. (Mimeographed)

From "SUMMARY". p. 2. "7. When the recent outbreak of 'red tide' was reported, a team of biologists and hydrographers proceeded to the area. A vessel was chartered, with the assistance of the Gulf Oil Company. Guided by air observation, a series of sections were made across the affected areas. The outbreak was found to be caused by the same organism *(Gymnodinium brevis)* that caused the serious 'red tide' of 1947. A living culture of this organism is on hand at the Laboratory. Results of the observations are being studied to correlate hydrographic conditions with the outbreak."

MARINE LABORATORY, UNIVERSITY OF MIAMI. 1953. Quarterly report on fisheries research. *Florida State Board of Conservation* (December). Pp. 1-6. (Mimeographed)

p. 5. "A serious outbreak of Red Tide occurred during the final quarter of 1953. Several biologists of the Laboratory went to the area during the emergency."

MARINE LABORATORY, UNIVERSITY OF MIAMI. 1954. Quarterly report on fisheries research. *Florida State Board of Conservation* (March). Pp. 1-11. (Mimeographed)

A statistical correlation showed a relationship between Red Tide outbreaks and rainfall plus ground water level.

MARINE LABORATORY, UNIVERSITY OF MIAMI. 1954. Emergency report on the Florida red tide. *Florida State Board of Conservation* (January). Pp. 1-4. (Mimeographed)

This report consists of (a) summary of research results, and (b) recommendations.

MARINE LABORATORY, UNIVERSITY OF MIAMI. 1954. Red tide studies (Preliminary report, January to June 1954). *Florida State Board of Conservation* (August). Pp. 1-117. (Mimeographed)

"SUMMARY". "...

"...

"3. The Red Tide fish kill was shown in 1947 to be of the nature of a plankton bloom in which the dinoflagellate, *Gymnodinium brevis,* highly poisonous to fishes, is predominant. The present inquiry was directed to a concentrated study on *HOW* the outbreaks originate and *WHEN* to expect them. Because of the limited period (5 months) available it was believed this approach would be most productive. Incidental data has nevertheless accrued, which gives a clearer picture of the nature of Red Tide. Some speculation is also offered as to control measures.

"4. In the course of the work a survey was made of the scientific literature concerning plankton blooms throughout the world.

"5. Statistical methods were applied to determine empirically what meteorological and other ambient phenomena exhibited a significant correlation with Red Tide. The initial series of fish kills constituting a Red Tide cycle were found to occur most frequently in the month of October and within the dates of the new moon plus or minus three days.

"A cycle or series of outbreaks is most likely to occur when the annual rainfall of the Peace River drainage area is above the fifty year average. A correlation also exists between outbreaks and a high maximum annual discharge of the Peace River. The 12 month running average of Peace River area rainfall seems best for forecasting outbreaks. No correlation has so far been satisfactorily established with wind conditions, or with the height of the water table, but this work is being continued. The salinity of gulf water near shore is lower in Red Tide years. There has been no relation found between Red Tide and the production of pebble phosphate in the Peace River drainage area.

"6. The results of hydrographic studies carried out in previous years had demonstrated the presence of Red Tide at the interface between Gulf and Bay waters. Attempts were made to develop further these relationships, but no evidence was found to substantiate the idea of a more or less continuous front between Gulf and Bay waters along which the Red Tide progresses. It now seems far more probable that a periodic separation of masses of Bay water susceptible to Red Tide takes place at the mouth of the passes and that these masses move with prevailing currents, usually northward, slowly losing their identity by mixing and diffusion with the Gulf water.

"7. Evidence suggests that the initial fish kills are most active and that *G. brevis* blooms most often originate at the inner side of such passes as Boca Grande; and that the disturbance may then travel with currents while still active, mainly in a northward direction.

"8. Evidence tends to show that nutrient inorganic phosphorus content of the water decreases in its passages from the Peace River to the

passes and that organic phosphorus increases. The total phosphorus however, decreases, suggesting that a precipitation or sedimentation takes place at the passes. The Peace River is the main source of phosphorus, the Manatee River somewhat less and the Caloosahatchee least.

"9. Evidence is offered that Red Tide may possibly involve more than one toxic bloom organism and it is therefore considered possible that greater progress may be made in future research by concentrating on the nature of the mechanism that gives rise to these blooms rather than by studying the particular organisms which are characteristic of its climax.

"10. A study of commercial fish landings fails to reveal any significant decrease in the commercial catch in relation to Red Tide. This is being given more detailed study.

"11. A tentative working hypothesis of the origin and nature of Red Tide outbreaks is offered as a basis for further investigations.

"12. It is strongly recommended that advance planning be undertaken for the control of Red Tide should outbreaks occur in the fall of this or future years. The most practical method of alleviating the damage is considered to be by seining of dead fish while concentrated in the passes and at sea, before drifting on the beaches.

"It is considered that chemical control is more expensive and less likely to be successful than the control of dead fish by seining. Nevertheless, it is recommended that chemical treatment be applied at the passes at the earliest possible moment of a Red Tide outbreak in order to evaluate its usefulness.

"13. Since Red Tide conditions, once they appear outside of the Keys are probably self perpetuating to a considerable extent and thus difficult to control, it is suggested that attention be paid to the possibility of modifying the nutrient conditions of the Bay waters in such a way as to prevent Red Tide conditions from developing. A large scale fish culture program in the Bays, with the addition possibly of supplementary nutrients other than phosphorus might conceivably be brought about. Under these conditions the nutrient regime and the food chains might conceivably be changed so as to minimize the development of conditions suitable to Red Tide."

MARVIN, KENNETH T. 1955. Oceanographic observations in west coast Florida waters, 1949-1952. *Spec. Sci. Rep. U. S. Fish Wildl. Serv.*, (149): 1-32.

Chemical, meteorological, and hydrographic data from work done along the west coast of Florida between 1949 and 1952 are presented.

MOORE, H. F. 1910. The commercial sponges and the sponge fisheries. *Bull. U. S. Bur. Fish.*, *26*(1): 399-512.

So-called "poison water" is reported as being responsible for the almost complete extermination of sponges from large areas. This phenomenon is said to recur at irregular intervals of about ten years. It is reported to have happened in 1878 between Johns Pass and Cedar Keys and in about 1895 from St. Marks to the mouth of the Suwannee River.

MOORE, M. A. 1882. Fish mortality in the Gulf of Mexico. *Proc. U. S. Nat. Mus. 4:* 125-126.

This is the publication of a letter originally written during November, 1880, by M. A. Moore to Professor Baird, Commissoner of Fish and Fisheries, Washington, D. C. He reports the cause of the mortalities of about 1878 and 1880 to be poisoned water and claims these waters seem to be centered more around the mouth of Charlotte Harbor and off Punta Rassa than elsewhere. The poisoned water seemed to affect

the bottom fish more than others. It is the opinion of this writer that volcanic action is the underlying cause of the phenomenon.

MURDOCK, JAMES F. 1954. A preliminary survey of the effects of releasing water from Lake Okeechobee through the St. Lucie and Caloosahatchee estuaries. *Marine Laboratory, Unversity of Miami* (Report to Corps of Engineers, U. S. Army). Pp. 1-89. (Mimeographed)

pp. 47-48. "The phenomena causing the most damage to west coast interests during the past few years has been the 'Red Tide'. At present a study is being made by this laboratory of the factors which might operate to bring about a 'Red Tide'. It is suspected that these factors would be more likely to be found originating from inshore than from offshore waters. The alteration of the natural drainage features of south and central Florida by the work carried on by the U. S. Army Engineers is one of the factors being investigated. The data collected and analyzed to date does not eliminate the possibility that a continuing high rate of water release may be a contributory cause of Red Tide outbreaks. On the other hand, since Red Tide outbreaks show a general correlation with the cumulative monthly rainfall of the peninsula, it is probable that the contributions of the Peace River and other drainage systems are sufficiently greater that a reduction of flow in the Caloosahatchee River would have little effect upon the probability of a Red Tide outbreak."

NICHOLSON, C. A. 1954. Blood in the Gulf. *Field & Stream* (August). Pp. 46-48, and 106-108.

A popular account of the red tide in Florida's waters.

ODUM, HOWARD T. 1953. Dissolved phosphorus in Florida waters. *Florida Geol. Survey,* Rept. No. 9, Misc. Studies, Part 1: 1-40.

"ABSTRACT. A basic survey has been made of the concentrations of dissolved phosphorus in many types of Florida's surface waters. The extensive deposits of phosphate rock in Florida lead to unusually high dissolved phosphorus contents in the streams and lakes whch drain these areas. Thus these waters are potentially of high fertility for growth of aquatic organisms. Additional quantities of dissolved phosphorus are being added by sewage and industry in some areas, although little recognition has been made of the possibly large biological effects that relatively small amounts of added phosphorus can have on those areas which are not receiving drainage from phosphate areas. The moderately low phosphorus content of basic springs in contrast to acid surface streams suggests a controlling role of pH in phosphorus solubility in Florida. It seems likely that percolating rainwaters are continually concentrating phosphorus in the layers just beneath the surface as the acid rainwater becomes basic. The natural and artifical phosphates contributed to Florida's surface streams hypothetically seem to be of the magnitude to contribute to red tide phenomena and the rapid growth of water hyacinths in prescribed areas."

ODUM, HOWARD T., J. B. LACKEY, JACQUELINE HYNES, and NELSON MARSHALL. 1955. Some Red Tide characteristics during 1952-1954. *Bull. Mar. Sci. Gulf and Caribbean,* 5(4): 247-258.

"ABSTRACT. Survey counts of *Gymnodinium brevis,* miscellaneous chemical analyses (Kjeldahl nitrogen, total phosphorus, total organic matter, chlorophyll, and nitrate), and a few light itensity and productivity measurements in Florida's red tide zone from 1952 to 1954 indicated a widespread general regime of this dinoflagellate growing sparsely in heterogeneous poor to moderately fertile water with a high N/P ratio. Occasional bloom patches and fish kills were accompanied by somewhat higher nutrient levels. The fertile estuaries, Tampa Bay and Charlotte

Harbor, in contrast to the Caloosahatchee River are capable of stimulating coastal fertility with injections of nitrogen and phosphorus. Offshore mixing of high N/P ratio water of the Caloosahatchee estuary and the low N/P ratio water of Tampa Bay and Charlotte Harbor may produce a wide range of nutrient conditions. A decrease in estuarine pollution is suggested as a remedial experiment."

PHILLIPS, CRAIG, and WINFIELD H. BRADY. 1953. Sea pests. *Marine Laboratory, University of Miami.* Pp. 1-78.

The red tide phenomenon is discussed briefly in this booklet.

PIERCE, H. D. 1883. 53—The spawning of bluefish—an opinion of the cause of mortaliy of fish in the Gulf of Mexico. *Bull. U. S. Fish Comm.*, 3:332. (From a letter to Prof. S. F. Baird)

This author does not believe "fish kills" to be the result of poisonous waters. He attributes the mortalities to lowered water temperatures.

PIERCE, H. D. 1884. 142—Notes on the bluefish, mortality of Florida fishes, etc. *Bull. U. S. Fish Comm., 4*(17): 263-266.

This work is a continuation of that by PIERCE (1883). The suggestion is made that cold water possibly caused the 1880 epidemic on the Florida west coast.

PORTER, JOSEPH Y. 1882. On the destruction of fish by poisonous water in the Gulf of Mexico. *Proc. U. S. Nat. Mus., 4:* 121-123.

Included in this article is a letter by J. Y. Porter to Prof. Spencer F. Baird, Washington, D. C. In the letter one opinion as to the cause of the destruction of fish was that it was because of "the saturated condition of the water with dogwood *(Cornus Florida)*" and another theory was that volcanic eruption caused the mortality. Also in this work is a letter written by C. J. Kenworthy to the editor of "Forest and Stream" and a reply to this letter is also included. Kenworthy reports that the fish mortality problem demands investigation and suggests that a government dispatch boat located at Key West be used. This suggestion was seconded by the editor of "Forest and Stream". The editor states that his organization had already suggested the use of fluorescine to determine the origin of a boiling spring off the Gulf coast.

RATHBUN, RICHARD. 1887. The sponge fishery and trade. *U. S. Comm. Fish and Fisheries* (The Fisheries and Fish. Indust. U. S.), Sect. V, 2(23): 817-841.

"Poisoned waters" are reported and Ingersoll (1882) is quoted.

SATER, EDNA N. 1954. Florida's red tide problem. *Fish. Leafl. Wash.*, 420: 1-11.

"SUMMARY. Progress on Florida's red-tide problem since the 1946-47 outbreak can be summarized as follows:

"1. 'Red tides', noted for their discolored water, are caused by a tiny marine organism so small that it cannot be seen by the naked eye. *Gymnodinium brevis* is the scientific name of this fish-killing plague which also produces a 'gas' irritating to nostrils and throats of people.

"2. Rainfall, marsh drainage, salinity, wind, and temperature—in certain combinations—provide the physical conditions in which the red-tide organisms can get started. These organisms multiply rapidly and derive nutrients from the fish that are killed as well as from land drainage.

"3. Red-tide organisms are now being grown artificially in the laboratory, thus permitting the testing of different chemical compounds as control agents. Copper sulfate is the most promising to date.

"4. Federal and State research is coordinated and citizens' groups are organized to report the detection of new outbreaks and to assist in control measures in an emergency."

SHALER, N. S. 1890. The topography of Florida. With a note by Alexander Agassiz. *Bull. Mus. Comp. Zool. Harv., 16*(7): 139-158.

See AGASSIZ (1890).

SLOBODKIN, L. BASIL. 1953. A possible initial condition for red tides on the coast of Florida. *J. Mar. Res., 12*(1): 148-155.

"ABSTRACT. It seems likely that the occurrence of a discrete mass of water, with a salinity lower than that of normal Gulf of Mexico surface water, is a necessary prerequisite for the occurrence of red tide off the Florida Coast."

SMITH, F. G. WALTON. 1948. (1949). Probable fundamental causes of red tide off the west coast of Florida. *Quart. J. Fla. Acad. Sci., 11*(1): 1-6.

A discussion of the factors which evidently could reasonably account for red tide along the west coast of Florida. It is suggested that inorganic phosphorus may be the limiting factor of plankton growth in these waters at all times.

SMITH, HUGH M. 1898. The Florida commercial sponges. *Bull. U. S. Fish Comm., 17:* 225-240.

"Black" or "poisonous water" is reported and Ingersoll (1882) is quoted.

TAYLOR, HARDEN F. 1917. Mortality of fishes on the west coast of Florida. *Rep. U. S. Comm. Fish,* (Doc. No. 848. Issued June 13, 1917): 24 pp.

"Poison water" is reported to have periodically killed large numbers of fishes and other animals along the Florida west coast during the 75 years preceding 1916. The critical area for these "kills" was from Key West north to near Cedar Keys and the "kills" were reported for the years 1844, 1854, 1878, 1880, 1908, and 1916. The 1916 outbreak. which appeared progressively southward from Boca Grande to Marco, is discussed and the meteorological conditions are reported. It was stated that in November, 1916, two people in Fort Myers died from eating fish killed by this phenomenon. The species of fish killed are listed; a number of invertebrates, sea urchins *(Arbacia),* the horseshoe crab *(Limulus),* and sponges, were also noted. Barnacles, oysters, mussels, conchs, hermit crabs, and porpoises did not appear to be harmed. A discussion of the possible causes of this mortality include:

"(1) water from the Everglades charged with tannin and products of decomposition of palmettoes and mangroves; (2) extraordinary abundance of *Peridinium* known to have occasioned the death of fishes in different parts of the world; (3) a disease, fungoid, parasitic, or bacterial; (4) dilution of the water by unusually heavy rains; (5) an issue of gas, volcanic or natural; and (6) earthquakes or seaquakes."

According to the author, the sixth cause appears to have the most promising possibility.

UNITED STATES FISH AND WILDLIFE SERVICE. 1954. Red tide research. Issued in form of a newsletter (September). Pp. 1-4. (Mimeographed)

Experimental work on the control of red tide organisms by the use of copper sulphate is mentoned.

WALKER, S. T. 1884. Fish mortality in the Gulf of Mexico. *Proc. U. S. Nat. Mus., 6*(6): 105-109.

A discussion of a fish mortality during October, November and December of 1880. The statements of a number of local residents are included: This author's observations summarized are (p. 106):

"1. The dead fish were most numerous on the outside beaches and on the inside beaches of the outer line of keys.

"2. That dead fish were least numerous about the mouths of creeks and rivers, decreasing gradually as one approached such places.

"3. That the poisoned water was not diffused generally, but ran in streams of various sizes, as proven by fish dying in vast numbers instantly upon reaching such localities.

"4. That the fish were killed by a specific poison, as proven by the sickness and death of birds which ate the dead fish.

"5. The fish began dying on the outside beaches first, as Mr. Strand, assistant light-keeper at Egmont, reports them coming up first on the 17th of October, while Mrs. Hoy observed them first on the 1st or 2nd of November, at Little Manatee River.

"6. The examination of many hundred recently-dead fish revealed no signs of disease. The colors were bright, the flesh firm, and the gills rosy. The stomach and intestines appeared healthy."

WEBB, JOHN G. 1887. 5.- The mortality of fish in the Gulf of Mexico. *Bull. U. S. Fish Comm., 6:* 11-13.

This writer believes the fish mortality to be caused "by noxious and poisonous gases which permeate portions of the Gulf and its bays, and which are derived from underground streams of water that flow into the sea." (p. 11)

WILSON, WILLIAM B., and ALBERT COLLIER. 1955. Preliminary notes on the culturing of *Gymnodinium brevis* Davis. *Science, 121* (3142): 394-395.

"Table I. Medium for the unialgal isolation of *G. brevis* Davis. After all additions are made, there is approximately 110 ml of medium.

Aged sea water (salinity, about 36.5 ppt)	95.0	ml
Distilled water*	5.0	ml
NH_4Cl**	0.1	mg
KH_2PO_4**	0.05	mg
$MgCl_2 6H_2O$**	0.02	mg
$NaHCO_3$**	0.1	mg
$Na_2S.9H_2O$**	0.1	mg
Vitamin B_{12}	0.1	ug
Thiamine hydrochloride	1.0	mg
Biotin	0.05	ug
Soil extract†	2.0	ml
EDTA.Na (6 ml of 0.25-percent solution)	15.0	mg

* More or less may be required, depending on the salinity.

** Added as 0.5 ml of the following solution of the components of Van Niel's medium for sulfur bacteria: NH_4Cl, 0.2 g; KH_2PO_4, 0.1 g; $MgCl_2.6H_2O$, 0.04 g; $NaHCO_3$, 0.1 g; and $Na_2S.9H_2O$, 0.2 g to 1 lit of distilled water.

† Simmer for 40 min. a mixture of 500 g of garden soil and 1 lit of distilled water. Let it stand for 4 days and decant the supernatant. Repeat simmering and decantation until extract is clear. Our soil gives a yellowish-brown extract."

WITWER, STAN. 1954. Can science stop the deadly red tide? *The Atlanta Journal and Constitution Magazine* (8-15-54). Pp. 28-29.

A popular account of Florida's red tide.

WOODCOCK, ALFRED H. 1948. Note concerning human respiratory irritation associated with high concentrations of plankton and mass mortality of marine organisms. *J. Mar. Res.*, 7(1): 56-62.

"SUMMARY. 1. Nose and throat irritations, similar to those naturally occurring in the Venice Beach region of the Gulf coast of Florida during July 1947, can be produced by breathing air artificially laden with small drops of the Gulf of Mexico water which contains (or contained) 56 x 10^6 dinoflagellates per liter.

"2. The presence of naturally produced drops of sea water in the air along Venice Beach, Florida, during a time when respiratory irritation occurred, is indicated. Approximate drop size range and concentration is given.

"3. Simple experiments show that respiratory irritation is always associated with the presence of small drops of 'red water' in the air.

"4. 'Red water' stored without preservative for several weeks retained its irritating qualities apparently undiminished. The persistence of the irritant through weeks of storage without preservative and through large temperature changes indicates a rather stable substance.

"5. Drops from effervescing heated 'red water' were more irritating than drops from effervescing water at room temperature, and these later drops seemed more irritating than spray drops produced by the hand atomizer.

"6. The irritant passed through a fine bacterial filter (1 to 1.5 mircon openings).

"7. When air-borne, the irritant can be so reduced in concentration, by inhaling through absorbent cotton, that it ceases to affect the respiratory system."

ADDENDUM

FEINSTEIN, ANITA. 1956. Correlations of various ambient phenomena with red tide outbreaks on the Florida west coast. *Bull. Mar. Sci. Gulf and Caribbean,* 6(3): 209-232.

"ABSTRACT. Investigations have been made to determine whether any simple, linear correlations exist between Red Tide outbreaks and various ambient phenomena. Outbreaks are compared with rainfall, tropical disturbances, and river runoff. A pattern of cyclic recurrence of outbreaks is presented. An attempt is made to show the path of individual outbreaks."

THE CYANOPHYTA OF ASPALAGA, GADSDEN COUNTY, FLORIDA[1]

Ronald C. Phillips
Florida State University

The distribution and ecological significance of blue-green algae on limestone have presented problems from the time of the earliest phycological investigations to the present. Tilden (1897), working on calcareous algae in Yellowstone National Park, and Chodat (1898), studying the chemical mechanisms by which blue-green algae penetrate into their limestone substrates, were two of these earlier workers. Little research on calcareous Cyanophyta has been done since the turn of the century, except for general collecting and, of this, few observations have been limited to the calciphilic forms.

The geological importance of fossil blue-green algae has long been recognized. Seward (1894) attributes much of limestone formation to fossil Cyanophyta. Garwood (1913), discussing Paleozoic rocks, refers to their presence in many geological horizons. Glock (1923) states that these algae have been responsible for calcareous deposits from Cambrian times to the present. Dachnowski-Stokes and Allison (1928) note a marl bed formed by Cyanophyta in south Florida.

Often, these calcareous cryptogamic plants are found embedded in their own substrate. A heated controversy at the beginning of the present century related to the exact chemical mechanism whereby algal filaments gain entrance. Nadson (1900) decided that the algae secrete oxalic acid. Bachmann (1914) held that the dissolving action comes from carbonic acid which the algae form as part of their metabolism. The method has not as yet been determined. Many calcareous forms precipitate calcium salts on their thalli. Nadson recognized these as calcium oxylate. Geitler (1925) determined them to be carbonates, thus concluding the formation of carbonic acid by the algae.

Several investigators have made significant contributions to ecological and taxonomic studies of the calcareous Cyanophyta. A few of these men are: Ercegovic (1925), Geitler (1932), Fremy (1933-36), and Pia (1926). Extensive general collecting has been

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[1] Contribution No. 69, Botanical Laboratory, Florida State University

done in north Florida by Nielsen and Madsen and their students (1954-55). Melvin A. Brannon (1952) has also reported his collections from central Florida.

In places along the east side of the Apalachicola river from Chattahoochee to Bristol, there are limestone outcroppings forming steep bluffs. Between these bluffs are rich valleys. Aspalaga Bluff, Gadsden county, rises about 175 feet in a quarter mile from the water's edge (Harper, 1914). The topography is hilly and dissected by numerous ravines and small valleys with streams. Aspalaga, the site of a pre-Civil War boat-landing, lies on the east bank of the Apalachicola river at 38° 38′ N. latitude and 84° 54′ W. longitude.

Collections of the strata at Aspalaga were examined by the Florida Geological Survey. It was determined that there are three geological formations at Aspalaga: the first is of Tampa limestone, comprising the bluff area; the second is Hawthorne formation and is found on the river flood plain; the third is a Citronelle formation which covers the Tampa limestone and is found along the dissecting streams in the valleys.

The vegetation of the area is luxuriant. The uniqueness of Aspalaga was first noted by Croom (1834) when he found *Taxus floridana* Nutt. According to Gray (1875) Croom also collected *Torreya taxifolia* Arn. in this area and noted that the region was covered with long leaf pines, *Liquidambar, Magnolia grandiflora* L., and *Taxodium.* Schornherst (1941) states that *Torreya, Taxus, Croomia,* and certain other plants are restricted to the Apalachicola river bluffs. The reasons for this are somewhat vague, since the topography, geology, and soil composition vary throughout the range, and the climatic factors remain relatively constant. Cowles (1904) has suggested that we regard *Torreya taxifolia* Arn. as a northern mesophyte which was left stranded at the last retreat of the Pleistocene ice, and perhaps is preserved here because of the exceptionally favorable topographic conditions. He theorizes that the climate of the bluff section may be similar to preglacial climates, inasmuch as *Torreya* was apparently a widespread form.

The plant communities formed are favored by diffuse light and more than the normal amount of moisture, due to the density of vegetation. Proximity to the Gulf of Mexico and the Apalachicola river and a low altitude contribute to the mild, humid climate of the area (Schornherst, ibid.). Aspalaga lies in an area

receiving 50-60 inches of rain per year. Over half of this precipitation occurs from June to September; April and November are the drier months. The average annual temperature of Aspalaga is 67°-68° F. (U.S. Weather Bureau, 1954).

Two series of collections were made from the two naturally divided sections of Aspalaga during May-July 1955 and January 1956. One area was the exposed limestone bluffs facing the Apalachicola river. The other was in a heavily wooded, limestone walled canyon, back from the river.

A systematic pattern of collecting was followed by working directly through both sections from end to end. Three hundred and seventy-six specimens were collected from three geological formations and from fresh-water habitats. These specimens are now deposited for future studies in the cryptogamic herbaria of the Florida State University, the Chicago Natural History Museum, and in the personal herbarium of Dr. Francis Drouet.

Ninety collections of blue-green algae from Aspalaga were made before the present investigation was started. These were identified by Dr. Francis Drouet and are reported in this paper.

The citations of species' collections have been omitted for the sake of brevity. This information may be obtained in the library of the Florida State University (Phillips 1956).

List of Species

Anacystis montana (Lightf.) Dr. & Daily, *A. thermalis* (Menegh.) Dr. & Daily, *A. dimidiata* (Kutz.) Dr. & Daily, *Coccochloris stagnina* Spreng., *Stigonema panniforme* (Ag.) Kirch., *S. minutum* (Ag.) Hass., *Hapalosiphon fontinalis* (Ag.) Born., *Fischerella ambigua* (Nag.) Gom., *Mastigocoleus testarum* Lagerh., *Nostoc commune* Vauch., *N. ellipsosporum* (Desmaz.) Rab., *N. microscopicum* Carm., *Anabaena inaequalis* (Kutz.) B. & F., *A. oscillarioides* Bory, *Cylindrospermum muscicola* Kutz., *C. catenatum* Ralfs., *Calothrix juliana* (Menegh.) B. & F., *C. parietina* (Nag.) Thur., *Dichothrix baueriana* (Grun.) B. & F., *Scytonema guyanense* (Mont.) B. & F., *S. hofmannii* Ag., *S. ocellatum* Lyngb., *S. mirabile* (Dillw.) Born., *S. myochrous* (Dillw.) Ag., *Microcoleus vaginatus* (Vauch.) Gom., *M. paludosus* (Kutz.) Gom., *M. rupicola* (Tild.) Dr., *Porphyrosiphon notarisii* (Menegh.) Kutz., *Schizothrix calcicola* (Ag.) Gom., *S. lamyi* Gom., *S. purpurascens* (Kutz.) Gom., *S. muelleri* (Nag.) Kutz., *S. taylorii* Dr., *S. heufleri* Grun., *S. roseola*

(Gardn.) Dr., *Plectonema nostocorum* Born., *P. terebrans* B. & F., *Lyngbya putealis* Mont., *L. ochracea* (Roth.) Thur., *Symploca muscorum* (Ag.) Gom., *S. muralis* Kutz., *S. dubia* (Nag.) Gom., *Oscillatoria tenuis* Ag., *O. princeps* Vauch.

Of the eight generally recognized families of blue-green algae, six are represented in these collections. Nineteen genera and forty-four species are represented.

Collections made during the winter numbered seventy-five specimens as compared to three hundred and one collected during summer. The winter collections were made during a prolonged drought in the area. A number of these species were poorly developed morphologically, presumably because of this prolonged desiccation. The algal vegetation was luxuriant during the summer season of abundant rains, a prevailing overall shaded area, and warm temperatures, all optimal for algal growth. This probably accounts for the difference in luxuriance of growth present during the two seasons.

Of the forty-four species collected, forty were represented in the summer; twenty-three of these forty were found in winter and only four of these species were limited to winter collections. These are: *Calothrix juliana, Schizothrix purpurascens, Symploca dubia,* and *Symploca muralis.* Seventeen species were found in both winter and summer.

Limestone provides a substrate which favors both algal survival and development. *Scytonema myochrous* (Dillw.) Ag. is found in great mats on the faces of the limestone bluffs. When these algal mats are peeled off, the limestone surface is spongy and porous, indicating that the filaments secrete an acid which dissolves the limestone. The algae found on this type of substrate were at optimal growth and were found in their typical morphological state.

The author wishes to express his appreciation to Dr. Chester S. Nielsen for the guidance received in this study and also to Dr. Francis Drouet, Chicago Natural History Museum, for his assistance in the verification of the specimens.

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NOTES ON THE MAMMALS IN THREE HABITATS IN NORTH FLORIDA

Bette A. Starner
University of Florida

A study of the distribution of small mammals in three ecological situations in a wooded area in northern Florida was conducted during October, November and December, 1954. The site of the study was located approximately 12 miles northwest of Gainesville, Alachua County, in an area locally known as San Felasco. The three plots selected for trapping were located in Mesic Hammock, the climatic climax of the region, in Longleaf Pine Flatwoods and the ecotone between these two communities.

San Felasco hammock comprises the most extensive stand of hardwood trees remaining in Alachua County. Natural conditions are relatively undisturbed, as the area has been free from fire and logging for sometime. Characteristic and most abundant trees in the hammock are laurel oak *(Quercus laurifolia)*,[1] magnolia *(Magnolia grandiflora)*, and hop-hornbeam *(Ostrya virginiana)*. Common understory plants are the American holly *(Ilex opaca)*, horsesugar *(Smyplocos tinctoria)*, dogwood *(Cornus florida)*, sweetgum *(Liquidambar styraciflua)*, water oak *(Quercus nigra)*, shortleaf pine *(Pinus glabra)*, and blue stem palmetto *(Sabal minor)*, Panic grass *(Panicum* spp.) grows in the more open areas and the heavily shaded portions are blanketed with a thick leaf mold.

The topography of the pine woods is level and the soil is sandy. Longleaf pine *(Pinus palustris)* is the dominate plant. Plants of the understory include wax myrtle *(Myrica cerifera)*, clumps of saw palmetto *(Serenoa repens)* and wire grass *(Aristida stricta)*.

The dominate plant of the ecotone is live oak *(Quercus virginiana)*. Southern red oak *(Quercus falcata)* occurs in large stands, and characteristic trees from the hammock and flatwoods, on either side of the ecotone, are found. *Andropogon* is the principal herbaceous plant. The ground is covered with relatively little litter and large areas of bare sand are common.

[1] References for Botanical nomenclature are West and Arnold (1946) for trees and Small (1933) for other plants.

Methods

Small Sherman live traps were set at random, approximately 25 paces apart or in groups of five and were baited with a mixture of peanut butter, bacon grease, raw hamburger and corn meal. Twenty-four traps were set in the flatwoods for a total of 600 trap nights, 25 traps in the ecotone for 250 trap nights and 18 in the hammock for 90 trap nights. In the total of 940 trap nights involved in the study, 54 small mammals were taken, a frequency of capture equalling one individual per 17.7 trap-nights.

Steel traps and large wire traps were also placed in the three habitats wherever sign of larger animals was evident.

Collecting sites were visited daily insofar as possible.

Measurements are in millimeters and weights are in grams. They are given in the following order: total length, tail length, length of hind foot, ear length from crown to tip, and weight.

Account of Species

Didelphis marsupialis pigra Bangs, Opossum.—Denning sites were found in the hammock, where a single immature male was taken. Measurements were not recorded.

Cryptotis floridana (Merriam), Short-tailed Shrew.—A single female was trapped in the flatwoods at the entrance of an underground burrow beneath a well-decayed pine log.

Measurements: Head and body length 66 (tail missing), hindfoot 11; weight 5.1 grams.

Scalopus aquaticus australis (Chapman), Common Mole.—Mole tunnels were observed in the sandy road which traversed all study sites. No specimens were obtained.

Sylvilagus floridanus mallurus (Thomas), Eastern Cotton-tail.—Tracks and fecal pellets were observed in the flatwoods and ecotone.

Sciurus carolinensis carolinensis Gmelin, Gray Squirrel.—Nests and kitchen middens were plentiful in the hammock, although squirrels were rarely seen. No collections were made of this species.

Sciurus niger shermani Moore, Fox Squirrel.—One fox squirrel was seen at the edge of the hammock adjacent to the ecotone.

Geomys pinetis subsp., Pocket Gopher.—Mounds were present in both the flatwoods and the open, sandy areas of the ecotone, where they were more abundant.

Peromyscus gossypinus gossypinus (Le Conte), Cotton Mouse.—Although Moore (1946) records the cotton mouse from a variety of habitats it is interesting to note that in this study three males were taken, only from the hammock area.

One, which had fallen into an excavation, 3 feet deep and 2 feet wide, was found to have a bot fly larva, *Cuterebra,* lodged in the inguinal region. Alive, the larva measured 20.1 mm. X 10.3 mm.

Measurements of one male: 163, 65, 23, 8; 30 grams.

Peromyscus nuttalli aureolus (Audubon and Bachman), Golden Mouse.—One adult female was trapped at the base of a large fallen tree in the hammock. No tree nests were found. Her mammae were well developed but there was no obvious indication of developing embryos or placental scars.

Measurements: 152, 74, 8, 9; weight not recorded.

Peromyscus floridanus (Chapman), Florida Mouse.—Fifteen specimens, of which six were adult males, four adult females and five were male juveniles, were trapped in the ecotone. Three of these were taken in traps placed inside the entrance of gopher tortoise burrows. Another was taken in a trap placed underground, in a much smaller burrow, which may have been dug by the mouse.

Two females had well developed mammae. No embryos were found in the uterus of one examined.

Measurements of three adults are as follows: male, 169, 80, 25, 16; 25.4 grams; female, 188, 99, 23, 18; female, 198, 83, 23, 15; 33.1 grams.

Sigmodon hispidus subsp., Cotton-Rat.—The cotton-rat was found to be the most abundant mammal of the study area. On several occasions 19 rats were caught when 20 traps were set and often there would be two individuals in one trap. It was not unusual to see and hear them scurrying along the ground when walking through the flatwoods.

Five males, fifteen females and twelve of undetermined sex were trapped in the flatwoods. Only a single specimen, a male, was taken from the ecotone.

Procyon lotor elucus Bangs, Raccoon.—Fresh tracks were observed in the sandy edge of a small seepage stream, which drains from the hammock. Raccoons made frequent visits to the stream as indicated by numerous tracks.

Lynx rufus floridanus Rafinesque, Bobcat.—Bobcats were known to inhabit the area. Although they were not taken during the study period, in June, 1955, steel traps were set several miles northeast of the study area. An immature male was caught in a road-set baited for fox.

Measurements: 889, 162, 186, 81; 20 pounds.

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ADDITIONAL RECORDS OF PLEISTOCENE LIZARDS FROM FLORIDA

Walter Auffenberg
University of Florida

Up to a few years ago, fossil lizard remains from Florida were unknown. Vanzolini (1952) was the first to bring attention to the Miocene lizards of Florida by describing *Peltosaurus floridanus* from the Thomas Farm, Gilchrist County. Brattstrom (1953a) reported *Sceloporus* and *Eumeces* from the Pleistocene and/or Recent deposits of Vero, St. Lucie County. Auffenberg (1955) reported *Ophisaurus* from both Pliocene and Pleistocene deposits in the State.

The present paper deals with Pleistocene material collected recently, adding a few more genera to the list of fossil lizards previously known from Florida. It also provides an opportunity to indicate new localities from which fossil lizards have been obtained.

Specimens cited in this paper are found in the collections of the University of Florida (UF) and the Florida Geological Survey (FGS).

Fossil lizards are now known from the following Pleistocene localities:

Illinoian [1]

Haile II B (R 17 E, T 9 S, SW¼ of Sec. 24), near the town of Haile, Alachua County. *(Ophisaurus ventralis, Ophisaurus compressus* and *Anolis carolinensis).*

Arredondo I (formerly known as Kanapaha I, Auffenberg, 1955) (R 19 E, T 10 S, SE¼ of NW¼ of Sec. 22), near the town of Arredondo, Alachua County. (Locality A—*Anolis carolinensis;* Locality B—*Anolis carolinensis).*

Reddick I B (R 21 E, T 13 S, W½ of Sec. 14), approximately 1 mile south of Reddick, Marion County. *(Anolis carolinensis, Cnemidophorus sexlineatus, Ophisaurus ventralis* and *Eumeces* cf. *fasciatus).*

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[1] Stratigraphically these deposits seem to represent the Illinoian glacial period (Brodkorb, in press).

Wisconsin or Post Wisconsin

Bradenton Field I. One mile south of the business district of Bradenton, Manatee County, approximately 100 yards east of the Tamiami Trail, in the north bank of a drainage canal (Simpson, 1930, gives additional stratigraphic and faunal data). *(Anolis carolinensis).*

Winter Beach-Luther Locality (R 39 E, T 32 S, S½ of NE¼ of Sec. 3), approximately 5.6 miles north of the original Vero Beach locality, St. Lucie County. Herbert H. Winters correlates this deposit with the North American Thermal Maximum (personal communication). *(Anolis carolinensis).*

Vero, St. Lucie County. Brattstrom (1953a) has reported *Sceloporus undulatus* and *Eumeces* sp. from Stratum 3 of this deposit.

A number of lizard remains are known from deposits indicating definite admxiture of Wisconsin, Post-Wisconsin and/or Recent faunal zones. These are:

Itchtucknee Springs (R 16 E, T 6 S, W½ of Sec 7), approximately 5 miles west of Ft. White, Columbia County (Simpson, 1930, gives additional information). *(Anolis carolinensis).*

Rock Springs (R 28 E, T 20 S, Sec. 11), approximately 4 miles southeast of Mt. Plymouth, Orange County. *(Anolis carolinensis).*

Lithia Springs (R 21 E, T 30 S, Sec. 16), near Lithia, Hillsborough County. A list of fossil vertebrates from this locality includes Miocene marine, and Pliocene (?), Pleistocene and Recent terrestrial and fresh water forms. *(Anolis carolinensis).*

Material Examined

The fossil lizard material upon which the above is based is composed of the following:

Cnemidophorus cf. sexlineatus

A lizard belonging to the family Teiidae is represented by a single fragmentary dentary (fig. 1), collected from an Illinoian (?) deposit at Reddick I B, Marion County. The fossil dentary (UF 5089) is represented by the posterior portion of that element,

bearing nine biscuspid teeth, with spaces for two more. The Meckelian Groove is broad and open. The teeth are somewhat compressed, though not greatly so. The largest cusp is the posterior one.

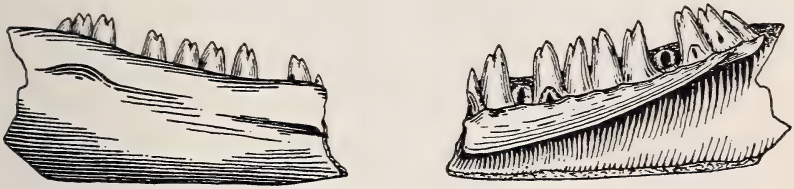

Fig. 1. A fragmentary fossil right dentary referred to *Cnemidophorus* cf. *sexlineatus*. External and lingual views. UF 5089, Reddick I, Marion County, Florida, Pleistocene, Illinoian?

The closest agreement is found between this fragment and the dentaries of four species of *Cnemidophorus* examined as Recent comparative material (*sexlineatus* - 4 specimens, *gularis* - 1 specimen, *tigris* - 1 specimen and *tesselatus* - 1 specimen). A concise specific identification seems impossible at the present time. The element is provisionally referred to the eastern species, *C. sexlineatus,* on zoogeographic grounds.

Anolis carolinensis

The dentary of *Anolis* is fairly diagnostic, and the presence of this lizard in fossil collections is easily determined if this element is available. It is long, low, with little curvature from above. The Meckelian Groove is very reduced in young specimens, and usually absent in adults; at least anteriorly. The teeth are pleurodont, well developed, slightly compressed, rather high, heterodont, bearing single cusps anteriorly, and three cusps posteriorly. There are no lateral striations on either the cusps or the shafts.

Remains of this lizard are very common in Pleistocene and Pleistocene and/or Recent deposits in Florida. It is now known from Illinoian and Wisconsin and/or Post-Wisconsin deposits. A number of dentaries, maxillae, a parietal, some frontals, a quadrate, a femur and a number of thoracic vertebrae are now available. It is known from the following localities:

Illinoian (?).

Haile II B. UF 5687, 3 frontals and 8 fragmentary dentaries. UF 5682, 1 femur and 5 fragmentary maxillae.

Arredondo I A. UF 5987, a fragmentary maxillary and 1 dentary.

Arredondo I D. UF 5094, a single dentary.

Wisconsin and/or Post Wisconsin.

Winter Beach-Luther Locality. UF 5829, 15 dentaries, mostly fragmentary, a number of isolated vertebrae, 6 frontals and 1 quadrate.

Bradenton Field I. UF (uncat.) several dentaries.

Pleistocene and/or Recent.

Itchtucknee Springs. UF 50913, 1 dentary.

Rock Springs. UF 5050, 1 dentary.

Lithia Springs. UF 5151, 1 dentary.

The dentaries of a number of modern species of *Anolis* cannot be separated. On the other hand, some species are quite distinct. *Anolis alliaceus* possesses 33 dentary teeth, being considerably more than are found in either the fossil elements, or in modern specimens of *carolinensis*. *Anolis cybotes* is quite distinctive in that the external surface of the dentary is decidedly thickened and rugose. This thickening does not occur on either the fossil elements or in Recent specimens of *A. carolinensis*. The number of teeth and the lingual dentary surafce in *A. cybotes* are very similar to those of *carolinensis*. *Anolis trossulus* and *A. equestris* both have a higher number of teeth than are found in either the fossil dentaries or in *A. carolinensis*. *Anolis equestris* is further separated on the basis of its large size. Neither the fossil elements nor the available Recent specimens of *Anolis carolinensis* can be separated from a number of West Indian anoles in which I have examined the dentary *(distichus, lineatopis* and *chloro-cyanus)*. Skeletal material of mainland anoles would undoubtedly show that many of these are also indistinguishable from the fossil specimens from Florida.

The fossil dentaries are identical in shape to those found in a large series of Recent specimens of *Anolis carolinensis*. The number of teeth in the fossil dentaries varies from 19-27 (M=22.5). In a large series (72) of skulls of Recent *A. carolinensis* the number of teeth varies from 19-25 (M=22.9). Two fossil specimens

(UF 9871), both from the same locality (Winter Beach-Luther), posses 26-27 teeth, a higher number than found in the larger Recent series of skulls. These elements are also larger than any other fossil or Recent dentary which I have seen.

The number of teeth in *Anolis carolinensis* is quite variable. There is no definite correlation between size of the individual and number of teeth. Some Recent West Indian anoles have a higher number of teeth than are found in *carolinensis (equestris, trossulus* and *alliaceus),* but there is little reason to refer the fossil elements to any species other than the form found in Florida today. Unless other evidence becomes available it seems best to refer the two fossil dentaries to this, rather than an exotic species of anole. A fossil dentary is illustrated in figure 2.

The fossil femora available from some of the Pleistocene deposits are of little value in determining the specific identity of the fossil anoles from Florida.

The maxillae (fig. 2) available from several Pleistocene deposits are identical to those in *Anolis carolinensis* in shape, rugosity, and number of teeth. However, they are also indistinguishable from a number of other species which I have examined. The number of teeth in this element in *carolinensis* varies from 15-22 (M=18.3). In the fossil elements the number varies from 17-21 (M=18.9).

The fossil frontals are of considerably more importance since rugosities reflect, in part, both keels and ridges in the supraorbital region; as well as, to some extent, scalation. Most of the fossil elements have at least some suggestion of a median frontal ridge. This ridge underlies the somewhat raised median row of scales between the orbits. This can be demonstrated in modern specimens of *carolinensis,* where the ridge is evident in especially large individuals. The structure is more conspicuous when it is not covered with scales, so that preserved or living specimens will show a less developed ridge than if the bone were exposed.

The structure is a common feature in many living species of *Anolis.* However, it is not found in all members of the genus. It is well developed in *Anolis carolinensis, A. brunneus* and *A. porcatus.* All of these species have small heavily keeled scales in this region, aligned in a median linear fashion. Presumably the frontals of *brunneus* and *porcatus* posses a bony ridge. The

structure seems best developed in *carolinensis.* Externally it is broader in *procatus* than in *carolinensis.* In the fossil elements the ridge, when present, is high and narrow, as in *carolinensis.*

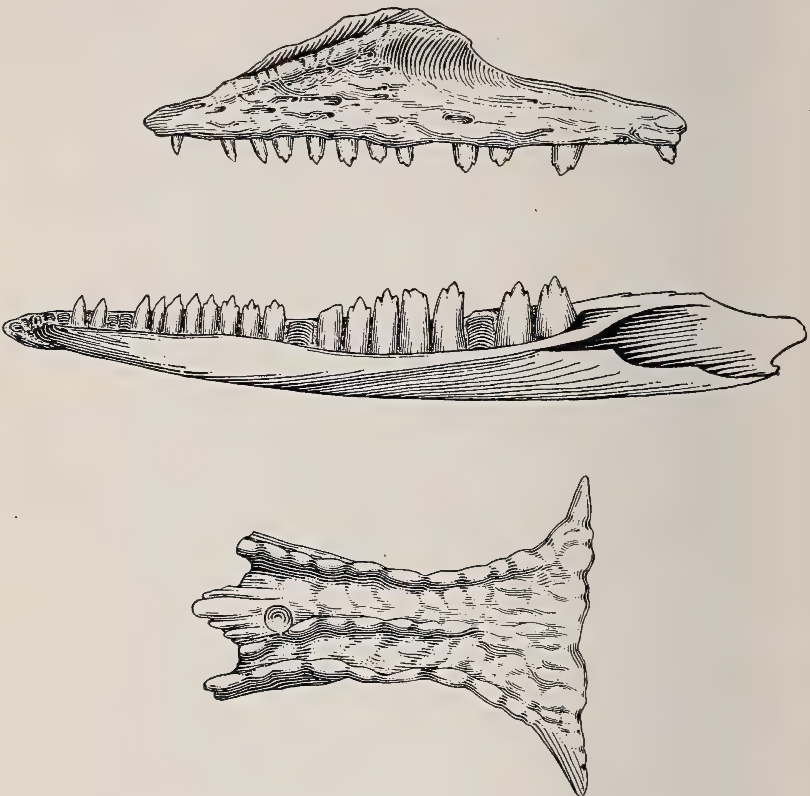

Fig. 2. Fossil skull elements of *Anolis carolinensis.* Upper. Left maxillary, external view. US 5829. Middle. Right dentary, lingual view. UF 5829. Lower. Frontal, dorsal view. UF 5829. All of the elements are from the Winter Beach-Luther Locality. Post-Wisconsin? Thermal Maximum?

One of the fossil frontals has the ridge developed to a greater degree than in any modern skulls of *carolinensis.* It is, however, one of the largest elements I have seen, and, judging from the modern series of *carolinensis* available, this character is correlated with age; the larger specimens possessing the highest and most well developed ridges. Individual and sexual dimorphism may also play a part in the observed variability of this character.

The sculpturing of the frontal in *Anolis* is apparently influenced by scalation. However, the exact shape of the rugosities do not reflect the boundaries of single scales. In preserved specimens a number of small rugosities underlie a single scale. It is therefore difficult, but not altogether impossible, to determine, in general, the scalation immediately above the frontal in the Pleistocene anoles.

The edges of the scales can be approximated by following the deepest "valleys" between the rugosities. The frontal scalation of the Pleistocene anoles of Florida, as reconstructed by this method, does not differ from that found in *Anolis carolinensis.*

A fossil frontal is illustrated in figure 2.

The maxillae of almost all of the larger comparative skeletons of *Anolis* are also provided with numerous small rugosities. Such sculpturing is also found on the fossil elements. However, the fossil maxillae differ from those in *A. porcatus,* where the upper surface is produced upwards and outwards, forming a very sharp and evident canthus. This ridge is covered by several long, narrow, and heavily keeled scales. A canthus is developed in the fossil elements, but not nearly as strongly, and the rugosities suggest much smaller scales in this area. The remaining external portions of the fossils are covered with fine sculpturing, but not strong enough to provide data concerning scalation in this area.

In all of the fossil elements there is a very close agreement between them, and there is every reason to believe that only one species is represented by these remains. Futhermore, the fossils are almost identical to the same elements from Recent skeletons of *Anolis carolinensis.* On the basis of other studies on reptile and amphibian faunas of Middle and Late Pleistocene deposits of Florida there is little reason to expect a species of *Anolis* in these deposits different from the one now inhabiting eastern United States. Two of the fossil dentaries have a slightly higher number of teeth than are found in *carolinensis.* It is interesting that these two elements are larger than any other fossil or Recent specimen known from Florida. Possibly correlated with this is the fact that both of these elements were taken from a deposit that may represent Thermal Maximum time. Brattstrom (1953b) has inferred slightly warmer climatic conditions for a single Pleistocene locality in California on the basis of a somewhat larger form of

rattlesnake of the viridis group *(Crotalus potterensis).* Cowles (1945) has applied Bergman's principle in interpreting past climates on the basis of size of reptiles in general. However, the problem of determining minor climatological shifts in the Pleistocene based on the size of a few vertebrae or dentaries is obviously quite complex, if not impossible. Temperature is certainly not the sole factor in determining size in local populations of reptiles. There are numerous examples of species of snakes in which more northern populations, living under cooler conditions, and in areas of shorter annual periods of activity attain a larger size than populations of the same species inhabiting more southerly regions.

Sceloporus undulatus

Brattstrom (1953a) has reported this species from Vero, Stratum 3, St. Lucie County, on the basis of two dentaries (FGS V-1530). No additional material has come to light since that time. It should be pointed out that Stratum 3 may represent admixture between Sangamon, Wisconsin, Post Wisconsin or Recent faunas. The genus is best included in a list of Pleistocene vertebrates of Florida on a tentative basis.

Ophisaurus ventralis

This species has been reported previously from both Pleistocene and Pliocene deposits in Florida (Auffenberg, 1955). It is now known from an additional locality (Winter Beach-Luther), perhaps representing Thermal Maximum time. The specimen is a thoracic vertebra (UF 5830). The vertebral ratios of this specimen fall within those of *O. ventralis* rather than *O. attenuatus* or *O. compressus.*

Eumeces cf. *fasciatus*

This genus has previously been reported from Vero, Stratum 3 (Brattstrom, 1953a; FGS V-1530). The stratigraphic problems associated with this local deposit have already been alluded to above. Two additional dentaries (UF 5086) are now available from Reddick I B, a definite Pleistocene deposit, probably Illinoian in age. One of these specimens in illustrated in figure 3.

The fossil elements have been compared with modern dentaries of *Eumeces laticeps, E. inexpectatus* and *E. fasciatus.* In addition,

the number of dentary teeth have been counted in a few other species.

There are no apparent differences between the dentaries of the available modern species and the fossils. They are similar in size, shape and proportions. However, the number of teeth is greater in the single complete fossil dentary (27) than in the species now inhabiting peninsular Florida *(E. laticeps* and *E. inexpectatus; E. egregius* is separable from the fossils on the basis of much smaller size). In *laticeps* and *inexpectatus* the teeth vary in number from 21-25. In *E. fasciatus* they range from 25-26. I have counted the following number of dentary teeth in several other species of *Eumeces: skiltonensis* 19, *tetragramus* 19-21, *humilis* 18-19, *schneideri* 18, *septentrionalis* 17-20, *chinensis* 23-24, *obsoletus* 20-21 and *longirostris* 18-20.

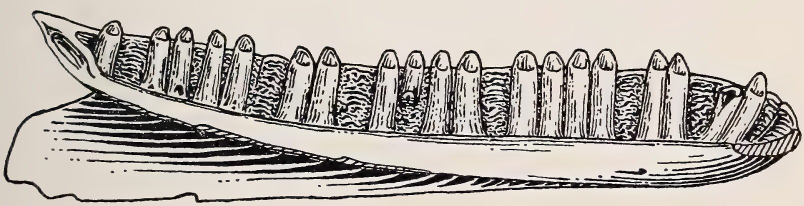

Fig. 3. Fossil left dentary referred to *Eumeces* cf. *fasciatus*, lingual view, UF 5086, Reddick I, Marion County, Florida. Pleistocene, Illinoian?

The number of dentary teeth in most species of this genus is thus lower than in the fossil. A much greater overall range in number of teeth is found in the iguanid, *Anolis carolinensis* than in any single species of *Eumeces.* However, it is not known whether or not the observed difference in variability is real, since the sample in *Eumeces* is much smaller than in *Anolis carolinensis.* On the basis of the skeletal material examined, the number of teeth is much more constant in *Eumeces* than in *Anolis,* and seems to provide a character of some merit in identifying fossil specimens of this genus. The question of the exact variability of teeth in lizards would seem to provide an interesting and worthwhile research problem. The character has been used many times in both paleontological and modern herpetological literature. Yet, no extensive studies have been made of this variability.

The shape of the cusps and shafts of the teeth of the fossil elements, the Meckelian groove and the shape and position of the external mandibular foramena are all in perfect agreement with *Eumeces.* Of the modern species, *E. fasciatus* comes closer in number of dentary teeth than any other species which I have been able to examine. On the basis of modern skulls of *E. laticeps* and *E. inexpectatus* there is little reason to believe that the number of dentary teeth in this genus is as variable as in *Anolis.* The fossil dentaries are thus referred to *E. fasciatus,* at least provisionally.

The presence of *fasciatus* in central Florida as a Pleistocene fossil is of considerable interest, since at the present time the form is apparently restricted to the extreme northern part of the State in the vicinity of the Appalachicola River (Neill and Allen, 1950). The deposit from which the fossils were taken is believed to represent Illinoian time, a period when more northern faunal elements would be expected to be present in the peninsula of Florida. The same deposit contains numerous remains of *Carphophis amoena,* a snake, which if present at all in Florida at the present time, is restricted to the northern portion of the peninsula (Auffenberg, 1956. Thesis).

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NOTES ON PHYSIOGRAPHIC FEATURES OF ALACHUA COUNTY, FLORIDA

Earl C. Pirkle, Jr.
University of Florida

Alachua County, covering an area of 961 square miles, is in the north-central part of peninsular Florida (see Figure 1). There is no complete, accurate topographic map of the county, but most of its central, southeastern and northeastern portions are covered by the U. S. Geological Survey's Arredondo, Hawthorn and Waldo quadrangle sheets respectively. There are no topographic maps for the western area of the county. Aerial photographs for the complete region are available.[1]

Physiography

A number of different subdivisions have been proposed for the Floridian Section of the Coastal Plain Province as defined by Fenneman (1938). According to Cooke (1939: 14, 1945: 8), Alachua County lies in the Central Highlands division of Florida (see Figure 2.) Vernon (1951: 16) proposed the term "The Delta Plain Highlands" to include Cooke's "Central Highlands." The inclusion of Alachua County in "The Delta Plain Highlands" presupposes a knowledge of the origin of the late Cenozoic formations in the county.

For convenience, Alachua County can be divided into the following three major physiographic areas as indicated by Sellards (1912, p. 34).

(1) A plateau-like region north of Gainesville and including most of northeastern Alachua County.

(2) A western plains region.

(3) An area in the south-central and southeastern part characterized by flat-bottomed lakes, prairies and erosional remnants of the plateau.

[1] The material presented here was included in the introductory part of a dissertation prepared under the direction of the late Dr. John L. Rich and entitled "Pebble Phosphate of Alachua County, Florida." The dissertation was submitted to the graduate school of the University of Cincinnati to fulfill part of the requirements for the degree of Doctor of Philosophy. Some of the field expenses were paid by the Florida Geological Survey.

These areas can be visualized by an examination of the topographic map, figure 3.

Figure 1. Location of Alachua County, Florida

Plateau Area

North of Gainesville and including much of the northeastern part of Alachua County is a nearly level plateau-like area ranging in elevation from 150 to 200 feet above sea level (see Figure 3.) Loose sands at the surface are underlain by clayey sands and sandy clays of Pleistocene age throughout much of the region.

Since these are relatively impermeable, surface stream drainage has developed radially outward in all directions from the plateau.

Figure 2. Location of Alachua County with respect to topographic divisions of Florida. (After Cooke, 1939.)

At some earlier stage in the physiographic development, the higher parts of the plateau probably constituted a natural divide between drainage to the Gulf of Mexico and that to the Atlantic Ocean. Some of the present drainage still reaches the Gulf of Mexico by way of the Santa Fe River which flows from Lake Santa Fe along the northern border of the county to the Suwannee River and thence to the Gulf. Newnans Lake, which today receives drainage from the plateau (see Figure 3) is believed by Sellards (1910: 66) to have formerly drained through Prairie Creek into Orange Lake, finally reaching the Atlantic Ocean by way of Orange Creek and the St. Johns River. Later, Prairie Creek was

captured by the development of Paynes Prairie and Alachua Sink. Now, through a system of pumps and canals the drainage from Newnans Lake has been diverted from Paynes Prairie back into the drainage area of Orange Lake.

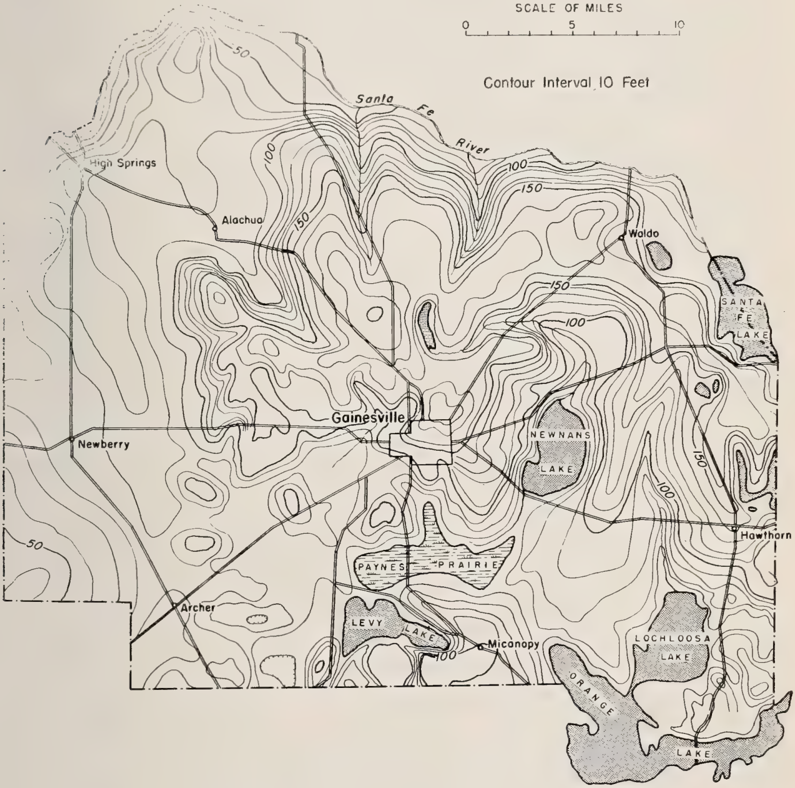

Figure 3. Generalized Topographic Map, Alachua County, Florida. (After U. S. Army Corps of Engineers.)

Many swampy areas containing peaty muck occur throughout the plateau. The depressions may have been formed by differential compaction of surficial Pleistocene sediments, or by solution of underlying calcareous rocks of the Hawthorne formation and the Ocala limestone. The importance of original irregularities in the Pleistocene sea floor can not be evaluated. The presence of the impermeable clays beneath the surface sands undoubtedly is responsible for the swampiness of any such depressions.

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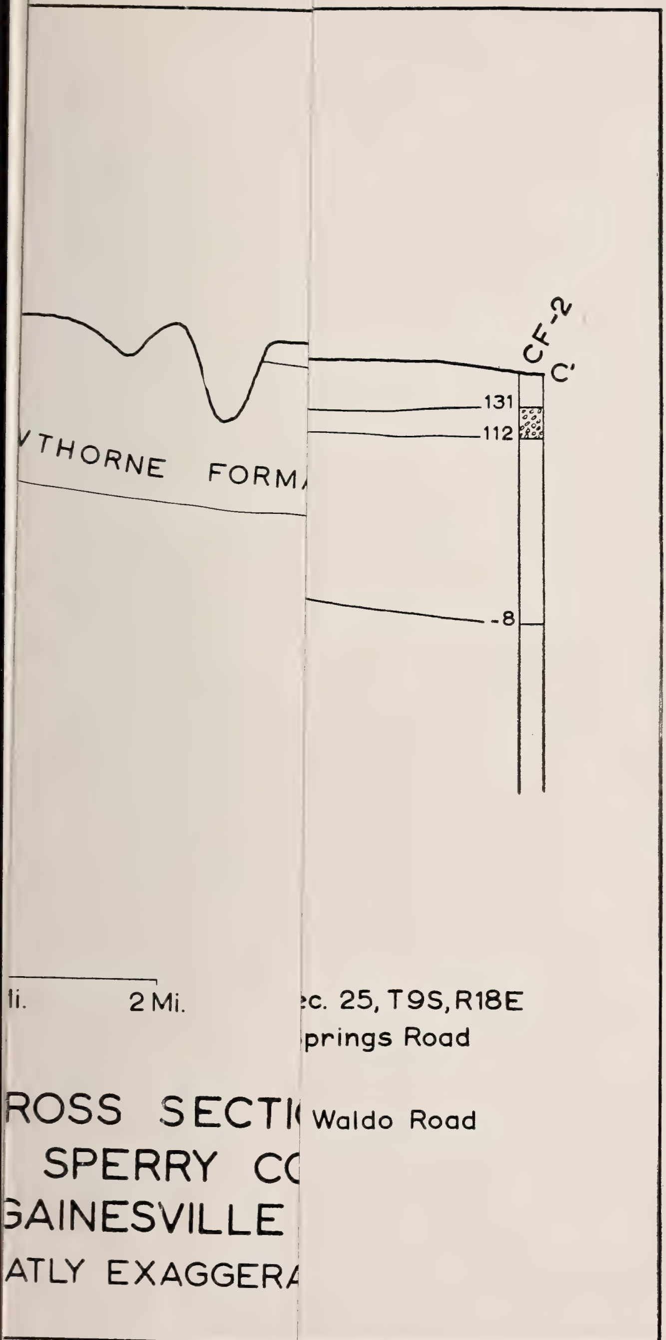
Figure 4. Aerial photograph showing part of the plateau area of Alachua County. Note surface drainage and shallow depressions dominated by trees. The northern part of Newnans Lake is shown in the lower right-hand corner of the picture.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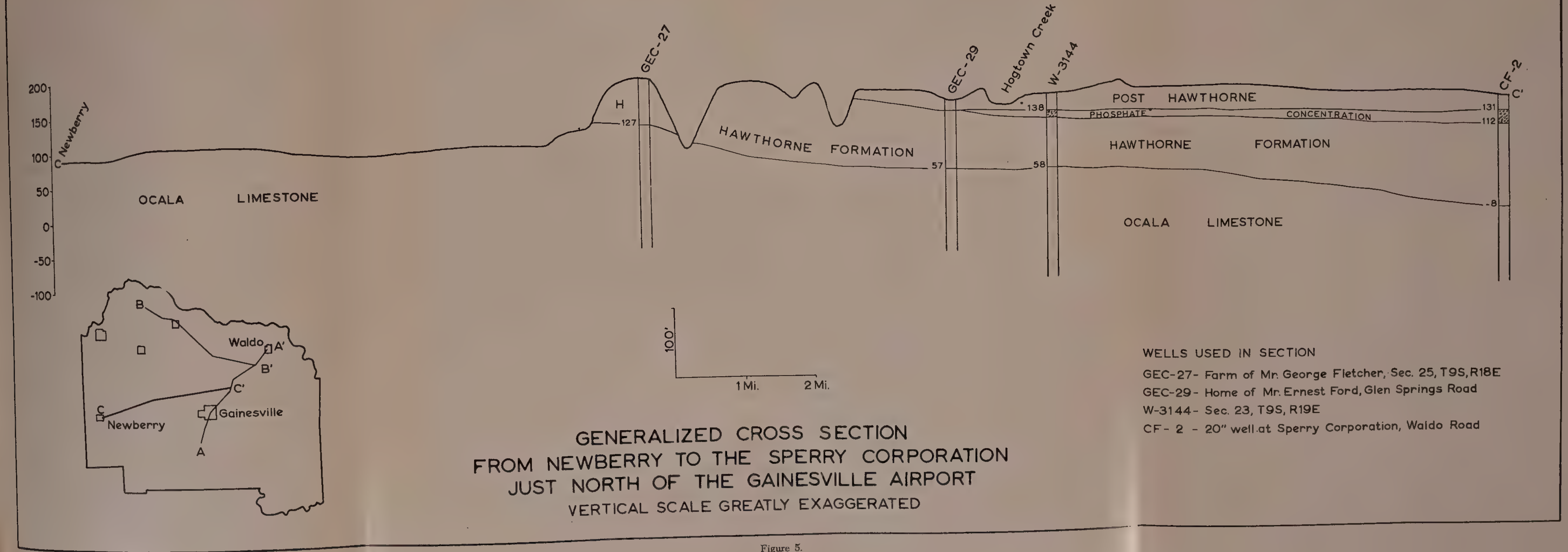

GENERALIZED CROSS SECTION
FROM NEWBERRY TO THE SPERRY CORPORATION
JUST NORTH OF THE GAINESVILLE AIRPORT
VERTICAL SCALE GREATLY EXAGGERATED

Figure 5.

Although sink holes are not common within the plateau area of the county, a few are found near its margins. The most notable such sink hole is the "Devil's Mill Hopper," a collapse sink approximately 125 feet deep resulting from solution in the underlying Ocala limestone. This sink is located about 6 miles northwest of Gainesville. Sheet wash and streams leading into such sinks, along with occasional collapse and slumpage of material from the sides play a part in the lowering of the plateau surface. During a rainy spell in the winter of 1952-53 an estimated 20 tons of sediment slid from the sides to the bottom of the Mill Hopper sink. By now, most of the loose sediment has been washed down into the cavernous Ocala limestone. The role played by this type slumpage and wash during past destruction of the plateau is difficult to assess, but it must have been considerable.

Part of the plateau surface with stream erosion conspicuous along its margin is well shown in figure 4. In that figure dense vegetation along streams appears as dark, branching lines, and slight depressions containing peaty muck show as dark patches. Surface erosion, particularly along the margins and into the sinks, is important in the continuing destruction of the plateau. Nevertheless, as is suggested by the pattern of swampy depressions shown in Figure 4, it must not be thought that the work of ground water is of no significance.

Western Plains Area

The western part of Alachua County is a plains area, ranging in elevation from 50 to 80 feet above sea level, throughout which the deeply pitted Ocala limestone is close to the surface (see Figure 3). This region is an extension of the Williston Limestone Plain of Levy County named by Vernon (1951: 32). It has resulted largely from the breaching by sub-aerial erosion of the Ocala arch (see Figure 5) and has been modified by the gradational work of Pleistocene seas.

The Ocala limestone in this area is covered by a thin veneer of loose sand. In places accumulations of clayey sand or sandy clay occur between these loose surface sands and the limestone. The loose sands, clayey sands and sandy clays fill the numerous solution features developed in the limestone and tend to mask the great irregularities of the limestone surface (see Figure 6).

In no other part of the county is the solvent action of ground water more evident than in this plain. Aerial photographs show many solution depressions, some of which have slight to dominant elongations in northeast-southwest or northwest-southeast directions. These directions are believed to reflect control by the joint system of the Ocala limestone. A number of faintly developed ridges follow these same trends. A few caves in the Ocala limestone have been partly mapped in Alachua County and are noted to follow these same directions. Even the outlines of small shallow lakes frequently reflect this joint control.

Figure 6. Smooth plain underlain by pitted and pinnacled surface of Ocala limestone. The limestone pinnacles are white and the clay and sand-filled pits are dark. Scale indicated by grass growing at the surface. Excavation on farm of Mr. Cummer in Section 35, T. 9 S., R. 17 E.

In a few cases, solution features seem to follow essentially north-south and east-west trends.

Sink holes from a few feet to more than 50 feet in depth can be found in almost any part of the plain. A group of trees in a field or pasture often indicates the presence of an open sink. Sink hole development no doubt started as soon as the Ocala limestone was raised from beneath the sea and still continues. Many old sinks have become filled with sediment due to subsequent marine submergences and rainwash. One exceptionally deep sink hole which has been filled with sediment is located on the farm of Mr. Homer Gravely (SW¼, Section 1, T. 10 S., R. 17 E.). There, a 10-inch irrigation well penetrated 268 feet of fill material, at which depth limestone was encountered. At the very bottom of the sink was 6 to 8 feet of muck. The surface elevation of the well is 92.69 feet above sea level. Ocala limestone is exposed at the surface in a sink hole only a few hundred feet from this well. In this latter sink hole the upper surface of the Ocala is approximately 15 feet lower than the top of the well. Several other sinks in the immediate area show Ocala at the surface.

Solution "pipes" (Figure 7) are common throughout much of the area. These cylindrical features range from a few inches to a few feet in diameter and from a few feet to 75 feet in depth. Various origins have been proposed for these solution features. They range from ideas dealing with tap-root growth of trees to Vernon's recent idea of the solutional work of artesian water. Vernon (1951: 44) states, "Since artesian water is under pressure it tends to expand upward along joints and more soluble rock because of greater porosity toward the ground surface. The localization of this movement vertically may explain the formation of solution pipes and 'natural wells.'" Probably downward solution along joints and joint intersections is a sufficient explanation for the formation of many of the "pipes" in Alachua County.

In the southwestern part of the county (Figure 8), this plain is covered by sand-hills and sand ridges. Some ridges of sand trend in a northeast-southwest direction, and others form arcs and irregular circles. These circular ridges seem associated with blow outs. The steepness of slopes and the trend of sand ridges suggest that the sand has been transported by winds from the southwest to the present site of deposition. The source of the sand probably was an area occupied by a Pleistocene sea not

far to the west of the county. In Figure 9, the region southwest of the railroad is typical of the sand-hill area.

Figure 7. Three solution "pipes" aligned along a joint in the Ocala limestone are shown in the central part of the picture. On the far side of the one in the foreground (near the hammer) a seam of flint is marked by white bands on either side. That seam, which pinches out downward, runs through seven solution "pipes" uncovered along this joint. The picture was taken at the S. M. Wall quarry in Section 35, T. 9 S., R. 18 E., where the overburden was removed and the irregularities of the limestone smoothed out with bulldozers in preparation for quarrying. The solution "pipes" were mucked out.

Slumpage due to solution of the underlying Ocala limestone probably has played a part in the irregularities of the sand-hills, and solution along a northeast-southwest joint direction of the Ocala could have played a part in the trends of some of the sand

ridges. More rapid solution in the Ocala limestone along a northeast-southwest joint direction would develop in the Ocala slight ridges and valleys which would follow this joint direction. Such ridges and valleys which developed in areas after the overlying sands had become stablized would tend to accentuate the northeast-southwest trend of sand ridges.

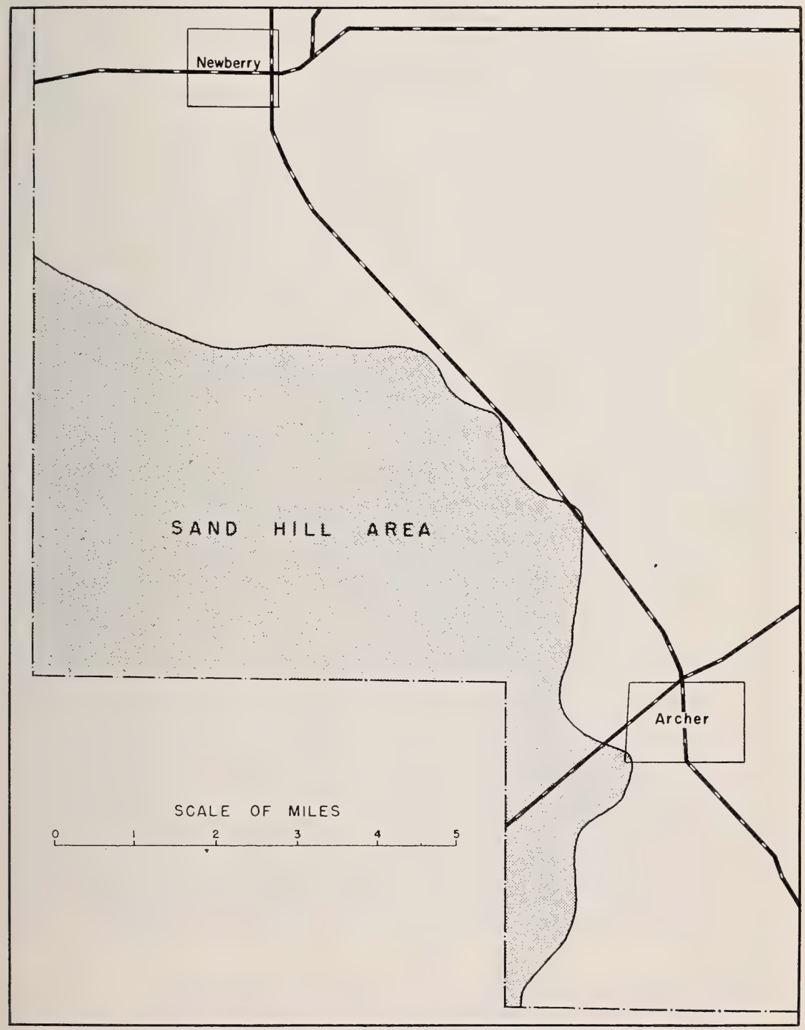

Figure 8. Location of sand-hill area in southwestern Alachua County.

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Figure 9. Aerial photograph of an area between the towns of Newberry and Archer. Most of the plains area to the left of the highway (State Road 45) is covered by hills and ridges of sand. The plains region to the right of the highway is devoid of such features. Note the tendency of some sand ridges to run in a northeast-southwest direction or to form irregular arcs.

A westward-facing escarpment separates this plains area from the plateau region of the county. It is believed that this escarpment is due to sub-aerial erosion of gently eastward or northeastward dipping Hawthorne beds. The plateau area frequently gives way to the plains region through a series of hills and ridges which are erosional remnants of the plateau. These remnants are composed of Hawthorne sediments.

South-Central and Southeastern Area

The south-central and southeastern portions of Alachua County are characterized by shallow flat-bottomed lakes, level prairies, disappearing streams and erosional remnants of the plateau (see Figure 3). This type of topography is visualized by Sellards as a transition stage in the reduction of the plateau area of the northeastern part of the county to the plains area of the western part.

The most fascinating topographic features are the flat-bottomed prairies and lakes of which Paynes Prairie, Levy Lake and Kanapaha Prairie are examples. Sellards (1910: 52 and 67) suggested that the underground water table is the base to which the level bottoms have been eroded, and that Sanchez Prairie near Hague and Hogtown Prairie southwest of Gainesville represent varying degrees in the development of large flat prairie areas.

The level bottons of the prairies and shallow lakes in this part of Alachua County are noted from topographic maps to occur at elevations somewhat below 60 feet above sea level. The following three different types of flat-bottomed depressions, all of which appear to be associated with the ground water level, can be recognized.

(1) Erosional surfaces developed on the Ocala limestone. In such cases the ground water level in the limestone seems to have determined this local base level. A thin layer of organic sediments covers these erosional plains formed by solution and tend to mask irregularities of the limestone surface.

(2) Erosional surfaces developed on Hawthorne sediments. Locally, erosional surfaces developed on Hawthorne sediments have undergone subsidence due to solution of un-

derlying Ocala limestone and have formed lakes and marshes.

(3) Depositional surfaces. Such surfaces have resulted from the filling of solution areas developed in the Ocala. Such solution depressions, some of which contained lakes at one time or another, have been filled by eroded Hawthorne and younger sediments transported to the low areas by rainwash and streams.

It is noted that the piezometric surface of the ground water of the Eocene limestones roughly corresponds to the level of all the types of flat-bottomed depressions. It may be possible that in this part of Alachua County as the Ocala limestone is approached in the present erosion cycle, the piezometric surface of the ground water of the Eocene limestones is serving as a temporary base level to which high areas are being eroded and low areas are being filled. The following examples are listed and briefly discussed to show that there are differences in the various flat-bottomed depressions, regardless of the fact that the surface elevations of the level bottoms are approximately the same.

Paynes Prairie, by far the largest of the prairies, has an east-west length of 8 miles and a north-south width varying from 1½ to 4 miles. Much of its 18,000 acres is excellent grazing land. Sellards pointed out that the flat floor of this prairie generally corresponds to the upper surface of the Ocala limestone and the ground water level of that limestone. Before a system of canals was constructed and huge diesel pumps installed, this area fluctuated between a flat-bottomed lake and a prairie as the ground water level changed or as Alachua Sink (the underground outlet) occasionally became plugged. The construction of canals throughout parts of the prairie shows that at least in the eastern portion the erosional plane developed on the Ocala limestone is almost at the surface, being covered by only a small amount of sediment rich in organic mater.

Only recently much of Orange Lake in the southeastern part of the county has drained simulating to a remarkable degree the drainages of Paynes Prairie. The disappearance of the lake water is associated with evaporation, transpiration and especially the lowering of the piezometric surface of the ground water. The ground water level has dropped largely as a result of sub-

normal rainfall over the past several years. With the lowering of the surface of the ground water, much of the water in the lake drained through a sink hole located in the southwestern part of the lake area.

In Alachua County not all areas with flat bottoms surrounded by sloping land have Ocala limestone near the surface. Just south of the main part of the University of Florida is a prairie-like area which contains Lake Alice in its western end. Only recently the eastern part of this level depression was drilled in detail for foundation studies in connection with the construction of the new University of Florida Medical Center. In this drilling program, holes were spaced 100 feet apart on a square grid, and drive samples or cores were taken every five feet. Casing was advanced with the holes. Thorough drilling of the eastern part of this level depression showed a very irregular surface of Ocala, with some drill holes going as deep as 200 feet and still not encountering the limestone, whereas other drill holes encountered the Ocala limestone at depths as shallow as 17 feet. A check along the slight cliffs bordering the prairie-like area showed Ocala actually exposed above the level of the flat bottom in one locality.

A well drilled near the east end of Levy Lake reached Ocala limestone at a depth of 90 feet. Thus, the Ocala in that well is much lower than the surface of the adjacent flat-bottomed Levy Lake.

Some workers have attempted to correlate the surface of these level depressions and the elevations of surrounding higher land with a Pleistocene sea invasion. One of the difficulties of relating the levels in this part of Alachua County to a Pleistocene marine invasion results from the fact that sloping land leads down from all directions to flat bottoms of prairies, and the elevations of the surrounding bluffs and slopes vary from place to place. Nevertheless, there is no doubt but that the topography of the area has been modified by the gradational work of Pleistocene seas.

Filled sink holes in the Ocala limestone are common in this part of the county. A number of wells have been drilled in such sinks. One exceptionally deep, filled sink was penetrated during the latter part of June, 1955, by a water well drilled on

the west side of the Archer Highway (SW¼, Section 14, T. 10 S., R. 19 E.) in the side yard of the home of Mr. J. P. Ahrano. The home is on a slight rise with Ocala limestone outcropping in a number of places in the immediate area. This well which has a surface elevation of 85.18 feet above sea level penetrated 198 feet of fill material before encountering a brown sandy limestone of uncertain age.

In summary, in the south-central and southeastern parts of Alachua County the dominant land forms are flat-bottomed lakes, level prairies and erosional remnants of the plateau. This type of topography has resulted from the erosion of the plateau. The level bottoms of the prairies and shallow lakes appear to be related to the ground water level; low areas caused by solution in the Ocala or underlying limestones tend to be filled with sediments up to the ground water level and high areas tend to be eroded down to that piezometric surface.

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Research Note

THE OCCURRENCE OF *FIMBRISTYLIS SPATHACEA* ROTH. (CYPERACEAE) IN FLORIDA. — This sedge has been collected several times in the past few years in South Florida. It is not included in the taxonomic works which treat the Southeastern United States. Collections have been made by (1) Jackson, sandy fill on bay side of Brickell Drive near Mercy Hospital, Miami, Feb. 1949; (2) Dickson, Cudjoe Key, Oct. 1951 and Big Pine Key, Nov. 1951; (3) Killip, open grassland, Big Pine Key, Nov. 1952, No. 42302. Specimens are deposited in the Buswell Herbarium, University of Miami and the University of Florida Herbarium. CURTIS R. JACKSON, Plant Pathology Department, University of Florida.

First Annual Report of the Committee on Science Talent Search of the Florida Academy of Sciences, May, 1956

INTRODUCTION

America has a vital need for more scientific manpower. Science Clubs of America in Washington have tried to solve this problem by the action of its Westinghouse Science Talent Search. Their power is limited and thus they sought the help of the state Academies of Science. The executive Secretary of Science Clubs of America, Miss Margaret E. Patterson, asked Dr. H. K. Wallace, then President-elect of the Florida Academy of Sciences, to create a Florida Science Talent Search to produce greater efforts in the search for scientific manpower on the local level. The Academy committee considered the request and approved of the plan.

The Committee

The following persons were appointed to constitute the committee to operate the Florida Science Talent Search for the Academy of Sciences:

M. M. Griffith	G. A. Thomas	R. A. Edwards
W. A. Gager	E. R. Jones	H. K. Wallace

R. D. MacCurdy, Chairman

The Activities

The committee decided to cooperate closely with the Florida State Science Fair Committee and to make the Science Talent Search an equal and parallel activity with the Fair. In doing this many advantages were obtained in the double use of committees on Registration, Housing, Entertainment, and Ceremonies. Also the students for S. T. S. competition were automatically free from school under the approval of the Science Fair provisions by the High School Activities Association.

The Junior Academy of Sciences agreed to "man the operations" of the main program for the search.

Sigma Xi society agreed to write letters of invitation and to be host for a dinner and career consultants to all the contestants.

The University of Florida offered its facilities for the activity.

The committee outlined the details of their tasks and proceeded to work as follows:

The Task To Do	*The Responsible Person*
Coordinator	R. D. MacCurdy
Secretarial duties, Press	R. D. MacCurdy
Records, Archives, Finance	R. A. Edwards
Sigma Xi	M. M. Griffith
Housing	M. M. Griffith
Registration, Message Center	W. A. Gager
Open Meeting, Announcements	W. A. Gager
Greetings	H. K. Wallace
Jr. Academy Convocation of S.T.S.	G. A. Thomas and L. Williams
Awards and Ceremonies	E. R. Jones

Committee then approved a program as follows:

Thursday, March 22, a.m. Engineering building.

10:00 a.m.	Registration, greetings, introduction from Pres. Wallace, Jr. Academy take over mechanics of meeting, Fair, Tours.
12:00 n.	Lunch
1:00 p.m.	Presentation of papers and demonstration.
5:00 p.m.	Close for supper.
7:00 p.m.	Participate in Science Fair program for evening.

Friday, March 23

9:00 a.m.	Papers
12:00 n.	Lunch
1:00 p.m.	Papers
5:00 p.m.	Close for supper with Sigma Xi and evening program with Sigma Xi.

Saturday, March 24

9:00 a.m.	Personal interviews with various judges. Go to the Science Fair.
1:00 p.m.	Awards Ceremonies with Science Fair.
3:00 p.m.	Close program. Finis.

"Judges" to attend S.T.S. for Florida to be

a. Committee for Jr. Academy
b. Committee for Sr. Academy
c. Committee for Fla. Colleges
d. Fla. Science Fair Contestants
e. Teachers
f. U. of Florida staff
g. Press and Public

Letters of invitation were sent to all the Florida colleges inviting them to participate in the evaluation and to offer the contestants scholarships.

The Evaluators

The following people were the representatives of Florida colleges:

Arthur W. Gay—Chairman Physical Sciences, St. Petersburg Jr. College
R. C. Beaty—Dean and Chairman Scholarships, University of Florida
Albert S. Johnson—Science Dept., Chipola Jr. College, Marianna, Florida
E. M. Miller—Dean of Arts & Sciences, University of Miami
Russell Johnson—Chairman, Physical Sciences, Florida State University
D. M. Jones—Science Dept., Pensacola Jr. College
Paul Vestal—Biology Dept. Rollins College, Winter Park, Florida
C. M. Pruitt—Chairman Physical Sciences, University of Tampa
W. D. Burgess—Florida Christian College, Temple Terrace, Tampa, Florida
T. W. Beiler—Stetson University, DeLand, Florida

They came, participated, and offered scholarships as follows:

From:

1. Pensacola Junior College—1 assistantship worth $100 a year for 2 years.

2. St. Petersburg Junior College—work scholarship 1 year renewable. (pays tuition $100.00) Prefer student interested in astronomy or chemistry with high school background in physics or chemistry or both.
3. Florida Christian—one 2 year scholarship. Pays tuition ($310.00 per year for 2 years). Additional scholarships available for those in upper ⅓ of class. Also work and loan funds are available.
4. Chipola Junior College—two 2 year scholarships which will pay: tuition, books, fees, and if living in dorms, room and a portion of meals. Additional estimated cost to students to be between $250.00 and $300.00 per year. Also work available on campus.
5. Stetson—either full tuition for 4 years or two ½ tuitions for 4 years. Tuition is $500 per year.
6. Florida State University—three $250.00 scholarships (one year subject to renewal). Two $150.00 scholarships (one year subject to renewal). One $250.00 to chemist. One $500.00 to chemist. Also a good many work scholarships at $30.00 per month.
7. Rollins—1 honor scholarships. $1200.00 per year for 4 years. But others may apply for additional scholarships.
8. University of Florida—4 full tuition scholarships. Additional scholarships and additional help will be made available if quality of students warrants.
9. University of Miami—Dean Morton Miller attending. 3 tuition scholarships. $650.00 per year for 1 year.

Other planned activities included the following:

1. Tours of the University of Florida campus and facilities
2. Reception at the Florida State Museum
3. Dinner with their host from Sigma Xi
4. Career conferences with U. of F. faculty
5. Attending (even competing in) the State Science Fair
6. Attending U. of F. night football game
7. Attending a lecture: Dr. James Oliver of New York Zoological Society on "Reptiles"

The Contestants

The students who completed entry materials and entered the competition of the National Westinghouse Science Talent Search did so by sending considerable material to Science Clubs of America in December of 1955. In so doing they followed directions and rules and completed the entry materials sent to them on their request from Science Clubs of America. When the national contest was finished and the results were announced all the entry materials from Florida students were shipped by Science Clubs of America to the Director of the Florida Science Talent Search. These completed entry packets furnished the name, address, and other useful data of all the contestants from Florida. These contestants and these alone were invited by letter to attend and compete for scholarships in the Florida Science Talent Search. The acceptance and turnout this year was 22 contestants.

Conclusion of Activities

Saturday afternoon in the Music Hall Auditorium the awards ceremony was held. This was a joint activity with the Science Fair Committee. The program was as follows:

Introduction and Greetings .... Dr. H. K. Wallace
Address: "Welcome to Science" .... Dr. John S. Allen
Awards: To S.T.S. .... Dr. E. R. Jones

Category 1:

To the 4 National Honorable Mention Winners, a collegiate membership in the Florida Academy of Science and awards of excellence scrolls.

Category 2:

To the next 10, honorable mention scrolls

Category 3:

To all others, certificate of merit scrolls

To all contestants:

An opportunity to win one of the offered scholarships. These are at this writing not all settled and are not yet announced in detail. Several have been accepted and awarded to date.

Evaluation

Follow-up evaluation forms were sent to all collegiate evaluators and to all contestants. On the basis of the returns the Committee plans changes and revisions which will improve this activity next year. The second Florida Science Talent Search is scheduled for April 11, 12, 13, 1957 at the University of Florida.

Respectfully submitted,
Robert D. MacCurdy
Chairman

INSTRUCTIONS FOR AUTHORS

Contributions to the JOURNAL may be in any of the fields of Sciences, by any member of the Academy. Contributions from non-members may be accepted by the Editors when the scope of the paper or the nature of the contents warrants acceptance in their opinion. Acceptance of papers will be determined by the amount and character of new information and the form in which it is presented. Articles must not duplicate, in any substantial way, material that is published elsewhere. Articles of excessive length, and those containing tabular material and/or engravings can be published only with the cooperation of the author. Manuscripts are examined by members of the Editorial Board or other competent critics.

MANUSCRIPT FORM.—(1) Typewrite material, using one side of paper only; (2) double space *all* material and leave liberal margins; (3) use 8½ x 11 inch paper of standard weight; (4) do not submit carbon copies; (5) place tables on separate pages; (6) footnotes should be avoided whenever possible; (7) titles should be short; (8) method of citation and bibliographic style must conform to JOURNAL style—see Volume 16, No. 1 and later issues; (9) a factual summary is recommended for longer papers.

ILLUSTRATIONS.—Photographs should be glossy prints of good contrast. All drawings should be made with India ink; plan linework and lettering for at least ½ reduction. Do not mark on the back of any photographs. Do not use typewritten legends on the face of drawings. Legends for charts, drawings, photographs, etc., should be provided on separate sheets. Articles dealing with physics, chemistry, mathematics and allied fields which contain equations and formulae requiring special treatment should include India ink drawings suitable for insertion in the JOURNAL.

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NOTES ON A KILLER WHALE *(ORCINUS ORCA)* FROM THE NORTHEASTERN GULF OF MEXICO

DAVID K. CALDWELL *, JAMES N. LAYNE *, and J. B. SIEBENALER **

On May 27, 1956, Caldwell, accompanied by Thomas and Evelyn Hellier, discovered the remains of a killer whale, *Orcinus orca* (Linnaeus) [1], washed up on the beach 6.5 miles east of East Pass (Destin), Okaloosa county, Florida. The specimen was in such an advanced state of decomposition that no precise external measurements could be taken nor sex determined. The part of the whale that was present measured about 15 feet in length, and it was judged that approximately one-fourth of the posterior portion of the body was missing. The flesh was so bleached and macerated that no color pattern was evident. Nothing could be learned of the circumstances surrounding the stranding of this individual, although a neat round hole in the temporal region of the right maxillary suggests that it may have been shot.

The left ramus of the lower jaw, nine right maxillary teeth (all that remained in the skull), and the left otic capsule were removed from the specimen on May 27. A rising tide and lack of tools prevented collecting more of the skull or postcranial elements. On June 4, 1956, a killer whale skull was recovered at the edge of the surf only a few hundred feet from the above locality and presented to Siebenaler. Since the mandible collected on May 27 exactly matches the upper portion of the skull and since the locality and

* University of Florida

** Florida's Gulfarium, Fort Walton Beach

[1] In employing the generic name *Orcinus* for the killer whale rather than *Grampus* as proposed by Iredale and Troughton (1933) we follow Ellerman and Morrison-Scott (1951) and Schevill (1954).

dates so nearly coincide, it is assumed that all of the skeletal material obtained is from the same individual.

Based upon the summaries of Ulmer (1941) and Moore (1953) of strandings and sightings of killer whales along the Atlantic coast of the United States, the present specimen constitutes the eighth individual known to have stranded and the fifth record supported by actual skeletal material. Two records based on specimens and six sight records are cited by Moore (1953) for Florida waters. Of these, only one, a single tooth in the United States National Museum collected near Everglades, Collier county, is from the Gulf of Mexico. Apparently the only other report of this species in the Gulf is a sight record of an individual off Port Aransas, Texas (Gunter, 1954). Killer whales have been reported along the east coast of the United States in the months of January, March, May, November, and December, the few records available failing to suggest any seasonal trend in occurrence.

Measurements of the skull and mandible (Figure 1) of the present specimen (No. 1507 in the University of Florida mammal collection) are given in Table 1. The asymmetry of the dorsal aspect of

TABLE 1

Skull measurements of *Orcinus orca* from near East Pass (Destin), Florida.

Measurements	Millimeters
Greatest length	902
Distance between outer ventrolateral lobes of occipital and vertex	457
Breadth across zygomatic processes (greatest breadth)	552
Breadth at center of orbits	457
Breadth across anterior orbital processes	419
Length of rostrum from level of bases of antorbital notches	467
Breadth of rostrum between bases of antorbital notches	252
Breadth of rostrum at mid length	249
Length of upper tooth row (from posterior wall of last alveolus to tip of premaxillary)	390
Least breadth of premaxillaries across anterior nares	183
Breadth of premaxillaries across middle of premaxillary foramina	143
Breadth of premaxillaries at mid rostral length	93
Greatest breadth of anterior nares	133
Breadth of occipital ridge between junctures with temporal ridges	317
Greatest breadth across occipital condyles	169
Breadth of foramen magnum	62
Height of foramen magnum	64
Greatest length of mandible	734
Length of mandibular tooth row (from posterior wall of last alveolus to tip of dentary)	371
Height of mandible at coronoid process	209
Length of symphysis	178

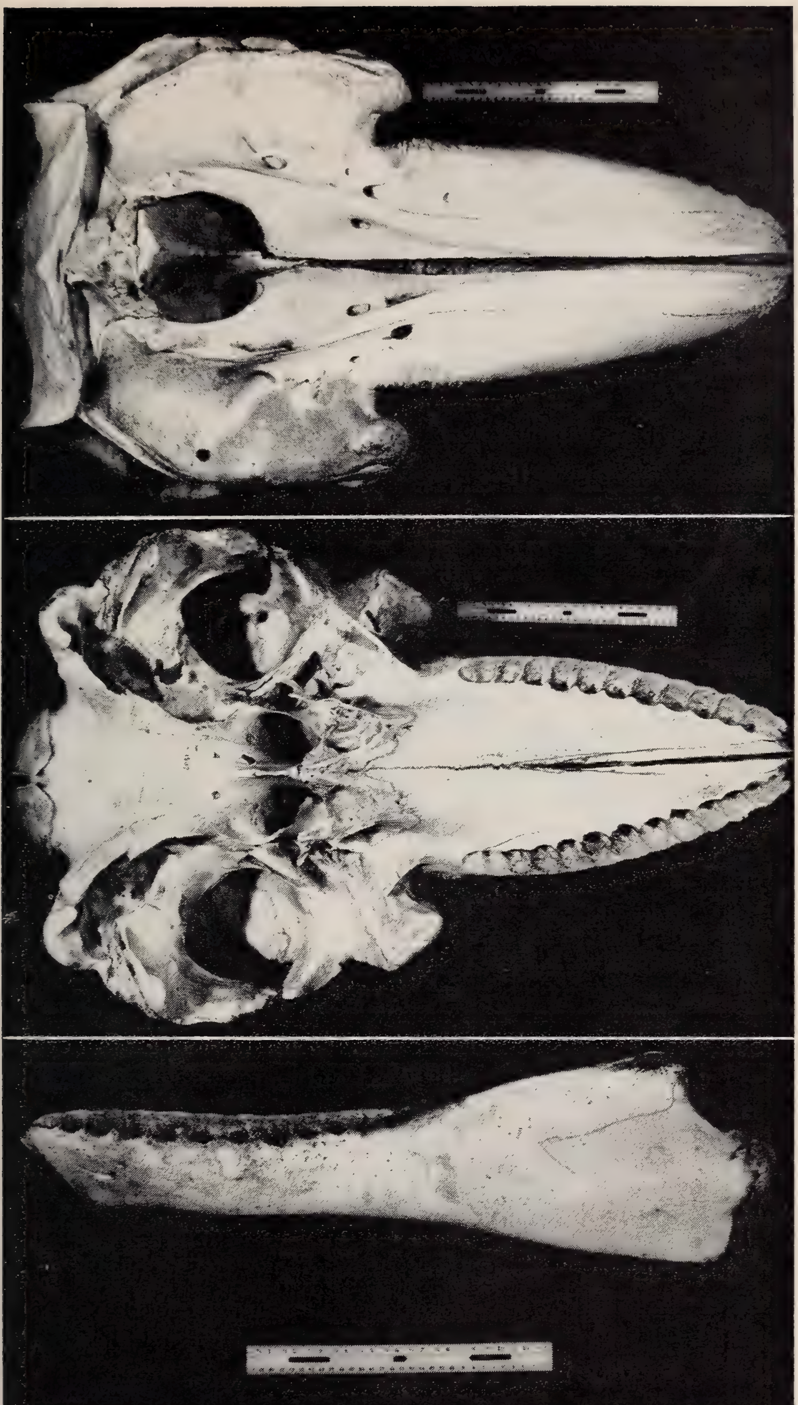

Figure 1. Killer whale skull from the northeastern Gulf of Mexico. *(Upper)* Dorsal aspect. *(Middle)* Ventral aspect. *(Lower)* Lateral view of left mandible.

the skull is most pronounced in the larger expanded portion of the right premaxillary and its more posterior extension than the left. The right premaxillary foramen is also distinctly longer than the left (26 mm. as compared to 22 mm.). The size and disposition of the maxillary foramina likewise differ on the two sides. The periotic and tympanic bones (Figure 2) are firmly fused, the latter measuring 70 mm. in greatest length. There are 13 apparent alveoli in each half of the upper jaw and 12 in the left mandible. The walls of both the upper and lower alveoli present a cancellous appearance and the majority of the septa are deeply notched.

The nine right maxillary teeth salvaged range in size from 28 to 85 mm. in greatest length. The roots of all appear to be normal in that the neural canal entering the pulp cavity is small and uneroded. The smallest tooth in the series, either the first or second in the tooth row, is poorly developed and in all probability was nonfunctional, perhaps not even exposed above the tissues of the jaw in life. It appears not to possess the heavier enamel coat of the other teeth and is flattened at the tip, the surface of which is roughened and unworn. This tooth also lacks the coating of calcareous material, previously mentioned as being present on the teeth of *Orcinus* by Ulmer (1941), that is deposited around the bases of the other teeth.

Differentiation of the teeth in the dental row is apparent, those in the first part being more nearly conical while those following have noticeably incurved tips. The wear surfaces on the individual teeth likewise vary in extent and pattern with the position of the tooth in the jaw. The crowns of the four anterior teeth available are most heavily worn in a slantwise fashion on the lingual surface and to a lesser extent on the back. The first and largest of the four hooked teeth is worn nearly flat on its apex and anterior surfaces. Also present is a deep, smooth, horizontal groove encircling the medial half of the crown about midway between the neck and the tip of the tooth (Figure 3). This groove becomes shallower and narrower toward the anterior face of the tooth. A somewhat smaller hooked tooth, believed to be the next in the series, exhibits a similar pattern of wear except that the tip of the tooth is worn obliquely in an anteroposterior plane, the rear margin being lower than the forward edge, and the horizontal groove on the lingual surface is smaller, though still pronounced. The anterior half of the groove is not nearly so deep nor as broad as the posterior part.

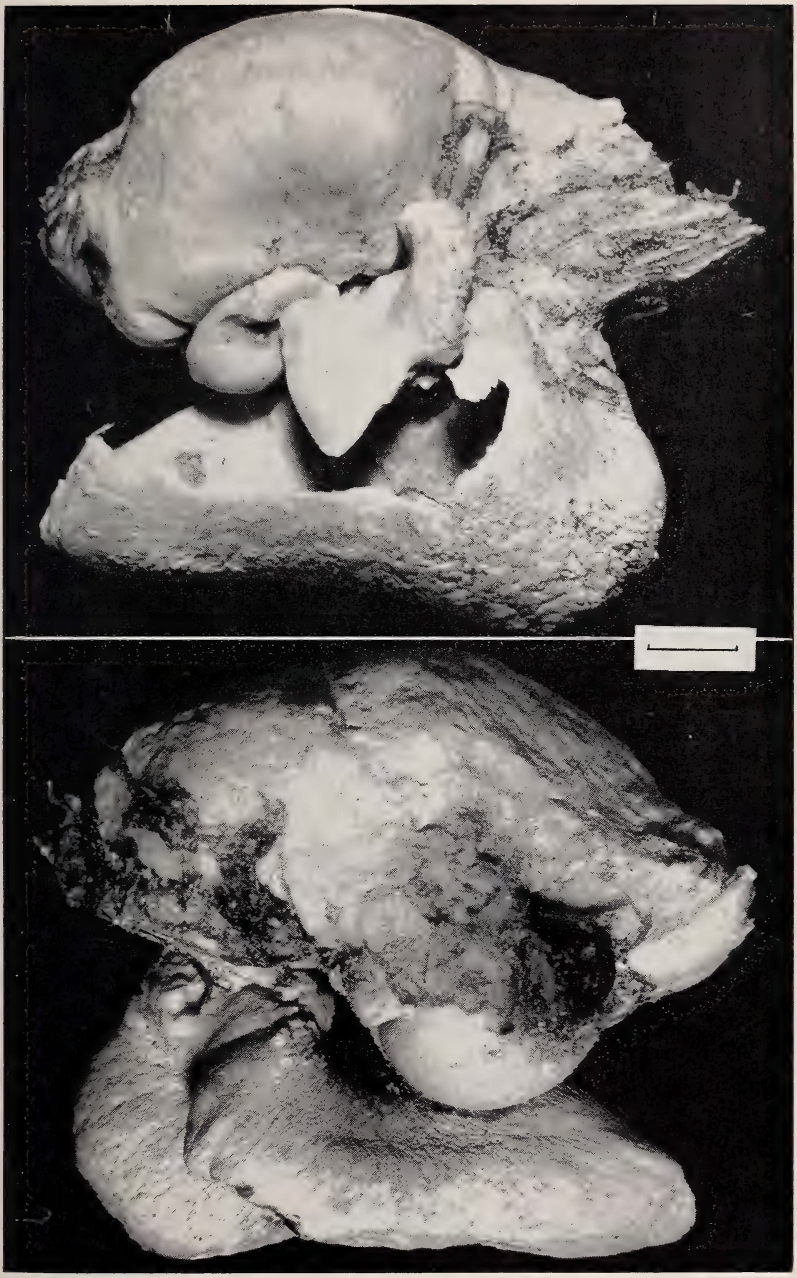

Figure 2. Left periotic and tympanic bones of *Orcinus orca*. *(Upper)* Lateral aspect (portion of tympanic wall broken away). *(Lower)* Medial aspect. Scale indicates one centimeter.

Distinct concentric rings are visible in the dentine of the worn tips of this and the previous tooth described and may represent growth rings. The only wear evidenced by the tooth presumed to be the penultimate one in the series is confined to the posterior face of the tip. The last tooth of those collected has only a small, roughly oval, patch of exposed dentine on the posterolateral aspect.

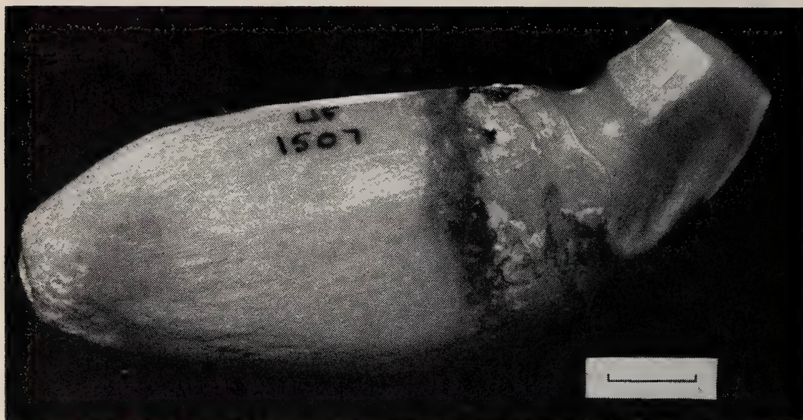

Figure 3. Anteromedial view of right maxillary tooth of *Orcinus* from about middle of dental row. Note wear surfaces on tip, anterior face, and horizontally on lingual side of crown. Also note calcareous deposits around base of crown. Scale equals one centimeter.

In his decription of the wear on the teeth of a New Jersey killer whale, in which the right mandible had been warped out of alignment and tooth wear at least on the right side was abnormal, Ulmer (1941) makes no mention of the presence of horizontal grooving as noted on two teeth of the specimen described here. The wear on the apex of the tooth and either anterior or posterior surfaces can be accounted for by the partial opposition and interlocking of the upper and lower teeth when the jaws are closed. The presence of both kinds of wear on the teeth of the anterior portion of the tooth row suggests that in this region the teeth may perform both a crushing and shearing action, the former perhaps predominating. A relatively greater shearing action might be postulated for the curved teeth toward the rear of the jaws in view of the fact that their tips are less or completely unworn and evidence of most marked attrition seems to be restricted to the anterior or posterior faces. The horizontal grooves, which may or may not be a normal

feature of tooth wear in this species, appear to be caused by the tips of the lower teeth moving past the uppers. It might be assumed from these particular wear patterns that the jaws perform not only vertical movements but palinal and lateral ones as well. A comparison of the shape of the mandibular fossa and articular condyle of the lower jaw of a typical dolphin such as *Tursiops truncatus* with the corresponding structures in the killer whale reveals morphological differences that may account for the possibly greater flexibility of jaw movements in the latter. The articular surfaces in *T. truncatus* are decidedly elongated transversely, and the condyle of the condyloid process fits snugly into the mandibular fossa. On an anatomical basis, action of the lower jaw would appear to be more nearly restricted to vertical movements, the upper and lower teeth simply interlocking to afford a secure purchase on the relatively small and weak prey pursued by these animals. On the other hand, the articular surfaces of the *Orcinus* jaws are relatively much less extensive and roughly subcircular in outline. Such an arrangement would seemingly provide for greater freedom of movement of the lower jaw and thereby permit an efficient crushing and rending as well as grasping action of the teeth. These structural and supposedly functional modifications of the teeth and jaws of the killer whale appear to be correlated with its highly predatory nature and the relatively large size of its prey as compared to the majority of the odontocetes.

We wish to express our gratitude to Dr. Joseph C. Moore, American Museum of Natural History, and William E. Schevill, Woods Hole Oceanographic Institution, for helpful suggestions and information on specimens of *Orcinus* accessible to them. Acknowledgment is also made to Robert D. Weigel, University of Florida, and A. Gilbert Wright, Florida State Museum, for assistance in the preparation of the photographs.

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THE HAWTHORNE AND ALACHUA FORMATIONS OF ALACHUA COUNTY, FLORIDA[1]

E. C. Pirkle
University of Florida

Introduction

The Hawthorne and the Alachua formations were named from exposures in Alachua County, Florida. For many years there has been no general agreement as to what materials should be included in these formations. In the published literature their stratigraphic relationships have constituted a lingering problem due to inadequacies of the original descriptions. The present study of these sediments in the type area was undertaken to contribute to knowledge of their nature, origin and age relationships.

The field work for this study was carried out at intervals from 1950-1955. During this interim, cuttings and cores from approximately 300 wells drilled in Alachua County were studied. Numerous other well cuttings, on file at the Florida State Survey in Tallahassee, were examined.

During the past several years, the writer was associated with exploratory drilling throughout many areas of Florida. Such work contributed data bearing on the stratigraphic problems of the Hawthorne and Alachua formations.

Acknowledgments

The writer is deeply indebted to the late Dr. John L. Rich without whose advice, active help and encouragement the work in which this material was included would not have been completed. Dr. Rich and Dr. William F. Jenks of the University of Cincinnati; Professor Harold K. Brooks, formerly of the University of Cincinnati; and Drs. Walter Auffenberg, Pierce Brodkorb and R. A. Edwards of the University of Florida have checked the field observations and spent many hours in going over the manuscript. They have offered valuable suggestions.

[1] This study was included in the introductory part of a dissertation prepared under the direction of the late Dr. John L. Rich and Dr. William F. Jenks. The dissertation, entitled "Pebble Phosphate of Alachua County, Florida," was submitted to the Graduate School of the University of Cincinnati to fulfill part of the requirements for the degree of Doctor of Philosophy.

Special thanks are due to the Gainesville Equipment Company and the American Metal Company, Limited, for aid and advice. Some of the field expenses were paid by the Florida State Geological Survey. To Dr. Herman Gunter and the other members of that Survey, the writer is indebted.

Location

Alachua County, covering an area of 961 square miles, is in the north-central part of peninsular Florida. There is no complete, accurate topographic map of the county, but most of its central, southeastern and northeastern portions are covered by the U. S. Geological Survey's Arredondo, Hawthorn and Waldo quadrangle sheets. Similar sheets have not been made of the western area.

Figure 1. Map of Florida showing location of Alachua County with respect to topographic divisions of Florida. (After Cooke, 1939.)

Aerial photographs for the complete region are available from the U. S. Department of Agriculture.

Alachua County has been placed in a number of different subdivisions proposed for the Floridian Section of the Coastal Plain Province as defined by Fenneman (1938). According to Cooke (1939: 14, 1945: 8), Alachua County lies in the Central Highlands division of Florida (Figure 1). Vernon (1951: 16) proposed the term "The Delta Plain Highlands" to include Cooke's "Western Highlands" and "Central Highlands." No delta sediments can be recognized in Alachua County, and no proof exists to indicate that such materials were ever deposited within that area. There appears to be no justification for including Alachua County in a "Delta Plain Highlands" subdivision.

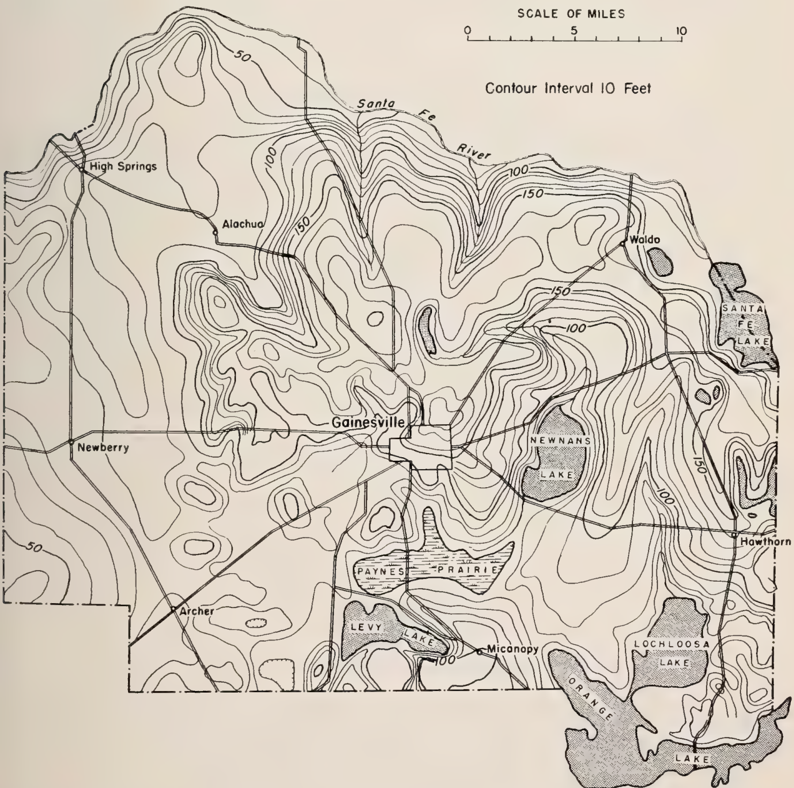

Figure 2. Generalized Topographic Map, Alachua County, Florida. (After U. S. Army Corps of Engineers.)

The best physiographic classification for Alachua County is that indicated by Sellards (1912: 34). He divided it into the following three areas:

(1) A plateau-like region north of Gainesville and including most of northeastern Alachua County.

(2) A western plains region.

(3) An area in the south-central and southeastern part characterized by flat-bottomed lakes, prairies and erosional remnants of the plateau. Sellards considered this type of topography as a transition stage in the reduction of the plateau area of the northeastern part of the county to the plains area of the western part.

These areas can be delimited by an examination of the topographic map. (Figure 2.)

Hawthorne Formation

The name "Hawthorne[2] beds" was applied by Dall and Harris (1892: 107) to phosphatic rocks being quarried near the town of Hawthorne in Alachua County. In referring to these phosphatic rocks, Dall stated, "The latter at the time of my visit was being quarried and ground up as a fertilizer at Hawthorne, where the beds have a considerable thickness. For this reason I referred to these beds in my unpublished report as the 'Hawthorne beds.' "

At the time of Dall's visit, phosphatic rocks were being quarried near the town of Hawthorne in the old C. A. Simmons' pits. As these pits are the only ones in that area from which phosphatic rock has been quarried and ground up as a fertilizer, they must be the ones referred to by Dall. The pits are located between the towns of Grove Park and Hawthorne, about 1½ miles south of State Road 20 in the eastern part of Section 31, T. 10 S., R. 22 E. on land now owned by Mr. Roy Brown.

Descriptions of Selected Exposures and Borings

Simmons' Pit Locality. Several early papers include descriptions of sediments in the general area of the old C. A. Simmons' pits.

[2] Wilmart (1938: 927) states that Hawthorn (without the final "e") is the preferred spelling. The town of Hawthorne is spelled with an "e" and Dall used a final "e."

A brief description and chemical analyses of rock quarried in the Simmons' pits were given by Hawes (1883). He stated, "There are very few stone quarries in the State of Florida—in fact almost the only one in actual operation is that at Hawthorne, in Alachua County, which is operated by Mr. C. A. Simmons . . . When saturated with its quarry water this stone is quite soft and can be cut with an axe or sawn with much facility . . . The material rapidly hardens when exposed to the air and sun, and some structures that were made of it thirty years ago are said to be still in good condition . . . The microscopic structure of this rock indicates that it is composed largely of angular grains of sand which are cemented together by a fibrous material which is probably the phosphate, and by a simple refracting substance which appears to be a mixture of kaolin and hydrous silica." Hawes called this rock a phosphatic sandstone and indicated the possibility of its use as a fertilizing material.

Hawes (Loc. cit.) listed the chemical analyses of two specimens of this rock. Both rock samples were described as porous and slightly yellowish in color. The mean of two analyses of each of the samples is listed below.

	Sample No. 1 Mean of Chemical Analyses	Sample No. 2 Mean of Chemical Analyses
SiO_2	46.765	50.73
Al_2O_3	19.57	12.85
Fe_2O_3	1.715	1.83
CaO	2.83	12.015
MgO	.215	.345
Na_2O		.32
K_2O		.33
P_2O_5	16.07	13.045
H_2O	14.28	8.39
CO_2		.86
	100.65	100.715

Penrose (1888: 78-79) in referring to phosphate deposits from the general area of the Simmons' pits stated, "The phosphate found

here belongs to the subdivision of phosphatic conglomerates . . . This conglomerate occurs in masses weighing from one to twenty pounds." He considered phosphatic conglomerates as cemented nodules of amorphous nodular phosphate. Penrose further stated, "In places the pebbles, rounded bones, and coral fragments occur loose in a calcareous matrix, as if weathered out of the original conglomerate."

In referring to a ridge in the area he stated, "The hill is overlaid almost entirely by a deposit of calcareous stones and pebbles, embedded in sand, which sometimes entirely runs out, and again reaches a depth of over six feet. Below is a soft, porous, calcareous rock, which is of a spongy consistency and hardens on exposure to air. It is quarried for building the chimneys and foundations of houses."

The masses of conglomerate and the calcareous stones and pebbles in a sand matrix referred to by Penrose represent a residual mantle developed by the weathering of sediments which originally consisted of phosphate pebbles and grains embedded in a matrix of sand and clay.

Cooke (1945: 147) in discussing local details of the Hawthorne formation included one paragraph concerning the type area of the Hawthorne. He stated, "Old pits in phosphatic limestone about 3 miles west of Hawthorn and about 2 miles from Grove Park were opened in 1879 by Dr. C. A. Simmons of Hawthorn, who ground the material and used it as fertilizer. When visited in 1913 the pits were so thickly overgrown that little could be seen except a few loose lumps of phosphatic limestone. The rock contained many shark teeth."

The writer has examined a few loose lumps of phosphatic rock found lying around on the surface in the area of these old phosphate pits. The specimens examined were not limestone but represented phosphatic sediments which had hardened on exposure and weathering.

Because the area around the town of Hawthorne, especially at the old Simmons' pits, represents the type locality of Dall's "Hawthorne beds," the nature of those sediments were determined as accurately as possible. Through the courtesy of Mr. Roy Brown (the present owner of the land) and the American Metal Company, Limited, seven shallow holes were drilled by means of hand augers

in and around the area of these old phosphate pits. Casing was advanced with the holes. Drilling was carried out by experienced crews from the commercial Bone Valley district.

In these hand-augered holes, it was found that 5 to 14 feet of overburden (consisting of loose sand grading down into clayey sand) covers 8 to 17 feet of Hawthorne sediments which contain abundant pebbles and grains of phosphate mixed with varying amounts of sand and clay. The strata containing heavy concentra-

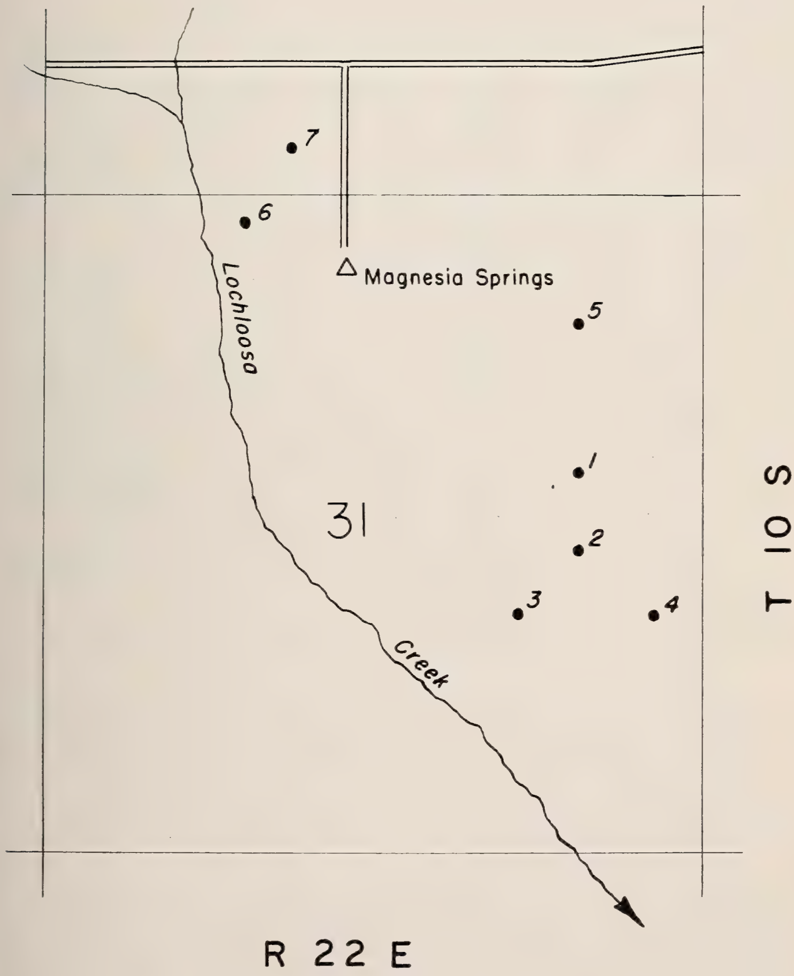

Figure 3. Location of borings on Roy Brown Property.

tions of phosphate pebbles and grains are underlain by a massive greenish to greenish gray clay. None of the borings reached the Ocala limestone.[3] Figure 3 shows the location of these borings. A log of hole No. 1 is presented to indicated the stratigraphy of the sediments. This log was made from samples collected every 6 inches and examined under a binocular microscope.

LOG OF HOLE NO. 1

Post-Hawthorne

0 to 1 foot—Dark brown, loose quartz sand and humus. Sand from fine to medium.

1 to 2 feet—Whitish, loose to slightly clayey sand. Sand from fine to medium with a few coarse grains. Occasional porous pebbles up to 1″ by 1½″ composed of sand embedded in a phosphatic clay.

2 to 4½ feet—Hardpan. Firm, brown to gray clayey sand containing fragments of sand-rock. Clay content and sand-rock fragments increase with depth. Sand-rock fragments consist of quartz sand cemented by a non-phosphatic clay. Clay is non-calcareous.

4½ to 7 feet—Grayish to whitish sandy clay or clayey sand. Same as above except soft and no fragments of sand-rock.

Hawthorne

7 to 10 feet—Grayish to buff clayey sand with abundant pebbles and grains of phosphate. Phosphate pebbles and grains dominantly white, but some brown.

10 to 14 feet—Grayish to buff clayey sand and sandy clay with a decrease in pebble size phosphate and a marked increase in grains of phosphate. From 10 to 11 feet, a gradual decrease in pebble size phosphate. Grains of phosphate are white, gray, tan and brown.

14 to 20 feet—Buff clayey sand with fewer but still common grains of brown, tan and amber phosphate. Bottom foot contains pebbles of brown and gray phosphate.

20 to 21 feet—Sandy phosphatic clay with occasional grains of brown, amber and black phosphate.

21 to 30 feet—Massive greenish to greenish gray clay with thin stringers consisting of a mixture of quartz sand and white phosphate grains. Embedded in the clay are numerous grains of soft white phosphate. At 30 feet, the clay has the appearance of fuller's earth and dries to a light gray or whitish color.

The summary of the hole is as follows:

0 to 7 feet—post-Hawthorne
7 to 30 feet—Hawthorne
Total Depth—30 feet in Hawthorne

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[3] Throughout this report the Ocala limestone is used as a formational name. Puri (1953a) has raised the Ocala limestone to the Ocala group. In this report no attempt was made to identify the various divisions of the Ocala.

TABLE I
ANALYSES OF PROSPECT
HOLES NO. 1 THROUGH NO. 5

HOLE NO.	FRACTION	TEST RESULTS		
		T/A	BPL	INSOL.
No. 1 (7/16½)	+14	3381	58.5	16.86
	14/20	1037	60.1	15.09
	Concs.	4771	68.8	4.95
	Product	9189	64.0	10.48
	T/A Ft.	557		
No. 2 (6/8)	+14	2704	58.6	15.66
	14/20	669	62.5	11.04
	Concs.	2413	69.2	3.14
	Product	5786	63.5	9.90
	T/A Ft.	723		
No. 3 (11½/8½)	+14	1032	58.3	17.16
	14/20	565	58.7	17.07
	Concs.	2340	70.0	2.99
	Product	3937	65.3	8.72
	T/A Ft.	463		
No. 4 (5½/9)	+14	2882	59.2	15.90
	14/20	758	62.9	11.27
	Concs.	1477	69.6	3.08
	Product	5117	62.8	11.51
	T/A Ft.	569		
No. 5 (14/15½)	+14	4293	61.2	17.01
	14/20	1109	61.5	13.34
	Concs.	4651	70.2	2.63
	Product	10,053	65.4	9.95
	T/A Ft.	649		
5 Hole Avg. (9/11½)	+14	2858	59.5	16.50
	14/20	828	61.2	13.54
	Concs.	3130	69.5	3.51
	Product	6816	64.3	10.18
	T/A Ft.	593		

Analyses run by the American Metal Company, Limited, of holes No. 1 through No. 5 are given in Table I. The following abbreviations used with the analyses are common terms in the commercial Bone Valley district and are used with the following meanings in reference to this drilling:

(7/16½)—Ratio of overburden (post-Hawthorne) to matrix. Matrix refers to sediments containing abundant phosphate particles. Seven feet of overburden to 16½ feet of matrix. The bottom 2 or 3 feet in hole No. 1 should not have been included for analyses.

Plus 14—Pebbles retained on 14 mesh screen.

14/20—Pebbles which passed the 14 mesh screen and were retained on 20 mesh screen.

Concs.—Concentrates. Grains which are larger than 150 mesh and which passed 20 mesh screen. Flotation size sediments.

Product—Total product. Derived by adding all plus 14, 14/20 and concentrates.

T/A Ft.—Tons per acre foot.

T/A—Tons per acre.

BPL—Bone Phosphate of Lime.

Insol.—Insolubles in various mesh sizes.

The sedments encountered in the borings show that in the area of the Simmons' pits two distinctly different types of Hawthorne materials occur. The top of the Hawthorne is a heavy concentraton of pebbles and grains of phosphate embedded in sand and clay. These sediments are entirely different from the underlying Hawthorne beds. Dall specifically referred to both types of sediments in the area as "Hawthorne beds." These two different types of materials taken together constitute a mappable unit.

The log of hole No. 1 shows other interesting features. Porous pebbles, consisting of quartz sand embedded in phosphatic clay, are present in the post-Hawthorne sands and clayey sands. Such pebbles are similar, if not identical, to pebbles resulting from the weathering of exposures of Hawthorne sediments today.

Within the top phosphatic zone, pebble size phosphate is more highly concentrated in the upper few feet. This same condition has been found in numerous areas throughout the plateau of Alachua County.

In the bottom foot of the phosphate concentration (at a depth of 19 to 20 feet), pebbles of phosphate again become common. Just beneath this increase in phosphate pebbles (at a depth of 20 to 21 feet), there occurs a phosphatic clay containing a few grains of brown, amber and black phosphate. Phosphatic clay of this same type is forming today from the weathering of the Hawthorne at some exposures. Beneath this 1-foot stratum is found massive greenish to greenish gray clay, which is sandy in places and includes numerous soft, white phosphate grains.

Throughout the area of the Simmons' pits, the beds beneath the top phosphate concentration zone carry lenses of *Ostrea normalis* Dall. Dall (1892: 110) mentioned the occurrence of silicified shells of this oyster in the mud at the bottom of Magnesia Springs which is only a short distance from the old pits. The location of the

Springs is shown in Figure 3. Many silicified specimens of this fossil can be found in Lochloosa Creek within a few hundred yards west of the Springs.

Holes No. 6 and No. 7 were drilled near Lochloosa Creek in an attempt to encounter a lens of undisturbed *Ostrea normalis* Dall. The sites for the borings were selected near the creek where it was believed that the top phosphate concentration zone would not be present. Such a location eliminated the necessity of hand augering through additional sediments. Hole No. 6 encountered these oysters although it can not be proved that they represent an undisturbed lens.

Exposure South of Grove Park. About 1 mile south of Grove Park in the eastern part of the SE¼ of Section 25, T. 10 S., R. 21 E., about 1½ feet of Hawthorne sediments similar to that quarried at the Simmons' pits are exposed in a road cut just west of a tributary of Lochloosa Creek. There the rock is composed of quartz sand and abundant grains and pebbles of whitish to tan phosphate embedded in phosphatic clay. Many of the phosphate grains are rounded to elliptical, and some show concentric structures in thin sections. Quartz sand is a common inclusion in many of the phosphate pebbles and grains. Thin sections show scattered grains of clastic feldspar including microcline in both the phosphatic clay and the phosphate particles. On exposure and weathering these sediments harden. Further weathering reduces the hardened rock to pebbles which often have a porous structure.

Brooks Sink. Brooks Sink, about 4 miles east of the town of Brooker in Bradford County and only a short distance north of Alachua County, furnishes the best exposures of the phosphatic Hawthorne. There, forty feet of such sediments are exposed and are overlain by forty feet of shell marl and covered slope. The sink is located in the NE¼ of Section 14, T. 7 S., R. 21 E. (Figure 4.) Sellards (1909: 240) included a section made at this sink. The following is a more detailed section than that made by Sellards.

SECTION AT BROOKS SINK

20. Covered interval .... 15′

Shell Marl (Upper Miocene?)

19. Cream or light colored shell marl, bedding distinct, some cross bedding .... 17′8″

Sediments of Upper Miocene age (?) (Possibly Hawthorne sediments)

18. Loose shell fragments and particles of calcium carbonate with

Figure 4. Brooks Sink, located about 4 miles east of Brooker in Bradford County. The best exposures of the phosphatic Hawthorne are found in this sink. These phosphatic beds are overlain by a shell marl of lower Choctawhatchee age.

slight amount of quartz sand grading downward into fine sand and particles of calcium carbonate with numerous shiny black phosphate grains .... 6′4″

17. Cream or light colored shell marl with scattered grains of small shiny black phosphate and quartz sand. Occurs as a ledge .... 1′2″

Hawthorne formation (Miocene)

16. Tan or buff mixture of carbonate and sand with common to abundant grains and pebbles of black and brown phosphate. Fossil impressions common. Occasional interior molds of large clams .... 1′6″
15. Tan to buff, more or less sandy limestone with impressions of fossils and a few grains of black phosphate. Occurs as a ledge .... 10″
14. Tan to buff mixture of carbonate and sand with common to abundant pebbles of brown phosphate. Thin zone of limestone pebbles near middle of bed. Limestone pebbles are sandy with many pebbles and grains of phosphate and abundant impressions of fossils, including gastropods .... 1′
13. Sandy limestone with common pebbles of brown phosphate and impressions of fossils. Occurs as a poorly developed ledge .... 6″
12. Tan to buff mixture of sand, clay and carbonate with a heavy concentration of pebbles and grains of brown and black phosphate. Numerous impressions and molds of fossils, mainly pelecypods .... 2′
11. Tan to buff mixture of sand, clay and carbonate with common brown and black phosphate grains. Impressions of fossil pelecypods .... 5′
10. Tan to buff sandy limestone with common grains of black and brown phosphate. Many fossil impressions, particularly big pelecypods. Occurs as a ledge .... 1′6″
9. Gray slightly calcareous to calcareous sandy clay with common grains of black and brown phosphate and numerous fossil impressions, mostly pelecypods. Weathers yellowish to tan .... 4′8″
8. Tan to buff sandy limestone with common small brown and black phosphate grains. Looks like a blue-gray sandy calcareous clay which has hardened. Occurs as a ledge .... 1′
7. Gray or blue-gray highly calcareous sandy clay with numerous small grains of shiny black and brown phosphate. Weathers tan or buff .... 3′3″
6. Gray or blue-gray, more or less sandy to sandy limesone, with included small black and brown phosphate grains and fossil impressions. Weathers tan to buff. Occurs as a ledge .... 7′5″
5. Gray or blue-gray, sandy calcareous clay with numerous small black, brown and gray phosphate grains. Clay weathers tan or buff. Scattered through bed are occasional whitish, poorly preserved pelecypods .... 2′

Diastem?

4. Layer of broken-up, mollusk-bored, blue-gray limestone. Weathers tan to buff. Many whitish, poorly preserved fossil fragments intermingled with and on top of the fragments of limestone .... 4″
3. Tan or buff colored, highly calcareous sandy clay with a heavy concentration of pebbles and grains of phosphate and rounded and angular small blocks of clay. Pebbles of phosphate are brown, gray and white. Grains of phosphate are black, gray and brown .... 1′11″
2. Cream or buff colored, more or less sandy to sandy limestone with occasional clusters of phosphate grains and pebbles. Bottom of

bed has a wavy, very irregular surface and shows solution weathering. Occurs as a ledge .... 1′10″

1. Top one to two feet of stratum has the appearance of a "breccia" with whitish limestone fragments embedded in a matrix of phosphate pebbles and grains, sand and clay. "Breccia" grades downward into blue-gray, more or less calcareous to calcareous sandy clay with phosphate pebbles and grains. Clay weathers tan or buff. Near bottom of stratum, in places, are numerous fragments of poorly preserved white pelecypod shells .... 5′10″

Total depth to water .... 80′ 9″

Gullies at the surface cutting back from the sink expose whitish sands, red and yellow clayey sands or sandy clays and greenish clay. Some of these materials are lower in elevation than the shell marl of bed 19, but most certainly are younger in age. A few discoid quartz pebbles occur in the sands.

All of the beds exposed are essentially horizontal, can be traced completely around the sink and contain remains or impressions of marine fossils. Cross bedding is conspicuous in the shell marl near the top of bed 19. From the exposures examined, the contact between the shell marl and the phosphatic sediments appeared to be gradational.

The top of the shell marl has been dated on the basis of ostracodes as lower Choctawhatchee in age (late Middle Miocene and/or Upper Miocene). In a personal letter dated May 3, 1955 Dr. Harbans Puri of the Florida State Geological Survey stated:

> I have examined the samples from the top of the shell bed, Brooks Sink, and they have yielded the following:
>
> *Microcythere stephensoni* Puri (Alum Bluff and Choctawhatchee)
> *Cytheretta choctawhatcheensis* Howe and Taylor (Chipola, Choctawhatchee)
> *Puriana rugipunctata* Ulrich and Bassler (Shoal River, Choctawhatchee)
> *Anomocytheridea floridana* Howe and Hough (Choctawhatchee)
> *Murrayina gunteri* Howe and Chambers (Oak Grove, Choctawhatchee)
> *Xestoleberis choctawhatcheensis* Puri (Choctawhatchee)
> *Loxoconcha* cf. *L. purisubrhomboidea* Edwards (Choctawhatchee)
> *Haplocytheridea bassleri* Stephenson (Alum Bluff, Choctawhatchee)
>
> The Foraminifera from this bed are very badly leached and replaced by dolomite and I regret my inability to identify any of them. The ostracode fauna, however, is comparatively well preserved and the fauna associations are of lower Choctawhatchee age.

The phosphatic sediments in beds 16 through bed 1 appear identical to those which have been encountered in the drilling of

Figure 5. "Breccia" zone in upper part of Bed 1, Brooks Sink. The area between the head of the hammer and the white limestone of bed 2 has been cleaned to reveal the brecciation. This "breccia" can be traced completely around the sink.

water wells at the town of Hawthorne. For example, a water well (surface elevation—151.31 feet) drilled at the City Hall in the town of Hawthorne penetrated 125 feet of such Hawthorne sediments. The following is a generalized summary of part of the well log.

0 to 40 feet—Post-Hawthorne. Mainly red and yellow clayey sand and sandy clay.

40 to 165 feet—Hawthorne. Similar to that exposed in Brooks Sink in Bradford County.

165 feet—Ocala limestone.

The color of the unweathered beds in the bottom of the sink (beds 1 through 9) is gray or blue-gray. These materials weather to a tan or buff color. It is probable that beds 10 through 16 were originally blue-gray or some other shade of gray. In some cases there is no question but that black phosphate pebbles have weathered to a brown color. The shell marl is cream to light colored.

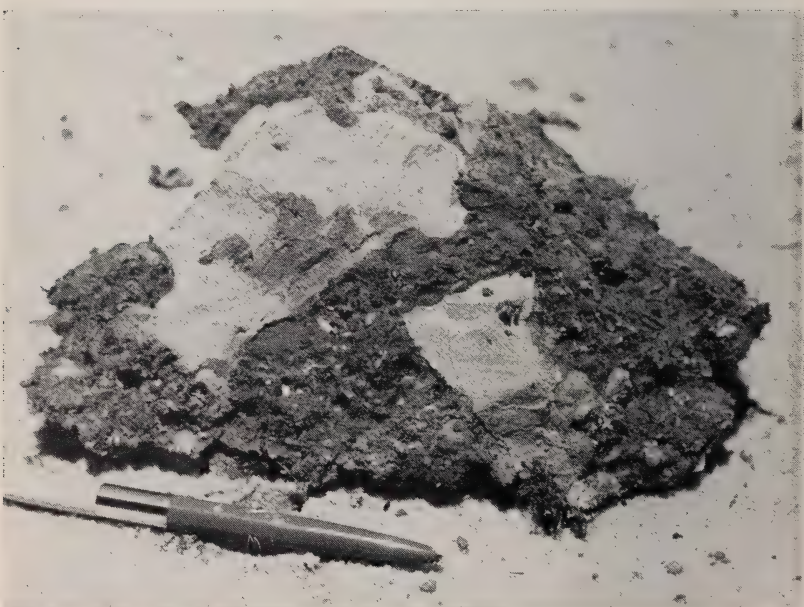

Figure 6. A block of the "breccia" shown in Figure 5. The white fragments of limestone are embedded in a matrix consisting of abundant pebbles and grains of phosphate, quartz sand and clay.

The grains and pebbles of phosphate occur disseminated throughout the sands, clays and carbonate and as concentrations in the form of lenses, irregular patches and as an abundant component of the matrix in the "breccia" near the top of bed 1 (Figures 5 and 6). Beds 3 and 12 as well as the top two feet of bed 1 contain heavy concentrations of pebble phosphate. The phosphate pebbles and grains in beds 3 and 12 apparently were swept in by storm waves and accumulated in a short time compared to that required for the deposition of other beds now exposed in the sink. Many specimens of sessile barnacles which appear to have been torn from their sub-stratum are present in these beds.

Some fractures and openings in the limestone of bed 6 are filled with secondary phosphate. It appears that phosphate was progressively deposited as solution of the limestone occurred. Phosphate was leached by descending groundwater from the phosphate pebbles and grains of overlying beds and deposited in cracks and other openings of bed 6 to produce a material comparable to the

Figure 7. Fragmented, mollusk-bored, blue-gray limestone from bed 4 at Brooks Sink. In these rock fragments, borings are from all surfaces.

"hard-rock" type phosphate of the Alachua formation of the western portion of Alachua County. It seems that this process is still taking place.

Bed 4 and the thin limestone pebbles of bed 14 furnish interesting complications. Bed 4 is a thin, broken-up, mollusk-bored, blue-gray limestone which weathers tan or buff. Some of the bore holes go inward from the top of the fragments, and others start from the bottom or sides (Figure 7). The presence of mollusk borings starting into the limestone fragments from all sides suggests that the fragments have been rolled about on the sea floor. The occurrence of bases of sessile barnacles on some pieces of the mollusk-bored limestone suggests that this diastem represents an interval of violent agitation followed by more gentle wave action conducive to sedimentary by-passing or slow deposition.

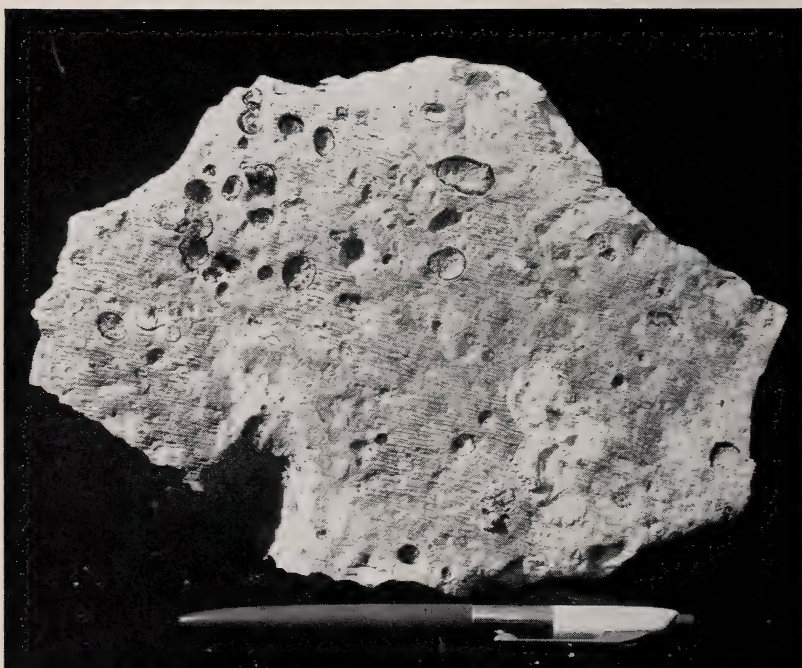

Figure 8. Striations on upper surface of a fragment of the blue-gray limestone from bed 4 at Brooks Sink. Note numerous mollusk borings. Bases of skeletons of barnacles are present on the surface in the lower right corner of the fragment. These barnacles could only have been present on a hard sub-stratum. This suggests extremely slow deposition or an unconformity.

Even though the limestone of bed 4 is only a few inches thick, it maintains its stratigraphic position and can be traced around the sink. Immediately over the pieces of limestone and intermingled with them are abundant poorly preserved pelecypods. The top surface of this rock in a few places has a striated or grooved appearance (Figure 8). The origin of these striations is not understood, but they may be slip marks. In the weathering of this limestone, lines of discoloration develop which form concentric rings around the bore holes. Fragments of similar appearing limestones are found near the tops of several beds around the sink. Phosphate pebbles which have been formed by the replacement of the carbonate content by phosphate of such limestone fragments have been noted in the Hawthorne formation and the Bone Valley formation.

The thin fragmented limestone in bed 14 is sandy, and includes many pebbles and grains of phosphate and fossil impressions. Some of the limestone pebbles seem case-hardened. Many pebbles scattered through Hawthorne beds look almost exactly like these impure limestone fragments. One of the common types of phosphate pebbles found in the Hawthorne formation appears to have formed from the replacement by phosphate of varying amounts of the carbonate content of similar limestone particles.

Devil's Mill Hopper. One of the best exposures of Hawthorne sediments in Alachua County occurs in the Devil's Mill Hopper, a sink located in Section 15, T. 9 S., R. 19 E. Cooke made a section of the strata exposed in this sink in 1913 (Cook, 1945: 147). Because of the many intervals of covered slope indicated by Cooke, the following detailed section was made by removing weathered and slumped material.

SECTION AT DEVIL'S MILL HOPPER

11. Loose, gray to white sand	3′
Hawthorne	
10. Abundant pebbles and grains of phosphate in a matrix of sand and clay	25′
9. Cream to yellow, calcareous sandstone or sandy limestone containing in places abundant molds and casts of marine pelecypods and gastropods. Locally, phosphate pebbles and grains are common	30′
8. Whitish to gray, dense dolomitic limestone	3′
7. Mainly blocky clay of fuller's earth type. Toward top of bed, in places, a grayish to blue-gray sandy clay. Microscopic crystals of pyrite are common in the blue clay	30′

6.	Limestone similar to bed 4	2½′
5.	Greenish gray to gray clay of fuller's earth type, similar to bed 3	4½′
4.	Sandy limestone containing many calcite fossil shells, angular blocks and rounded pebbles of fuller's earth clay, and phosphate pebbles and grains	1½′
3.	Greenish gray to gray, blocky clay of fuller's earth type, with a few phosphate pebbles and rare impressions of marine fossils	18′
2.	Dark colored, dense dolomitic limestone (partly silicified in places) with stringers of quartz sand. Grades down into a loosely cemented calcareous sandstone. Both dense limestone and sandstone contain included blocks of fuller's earth clay	2½′
1.	White to gray sand, loose to slightly cemented, contains a few brown phosphate grains and pebbles. Rare shark's teeth	3′
	Total depth	123′

The fuller's earth clay exposed in this sink is very fine grained and even-textured. A small piece of the clay, about the size of the head of a pin, when placed in immersion liquids and examined with a petrographic microscope reveals numerous included grains of fresh and angular orthoclase feldspar and quartz. Rare fragments of plagioclase, microcline and biotite are present.

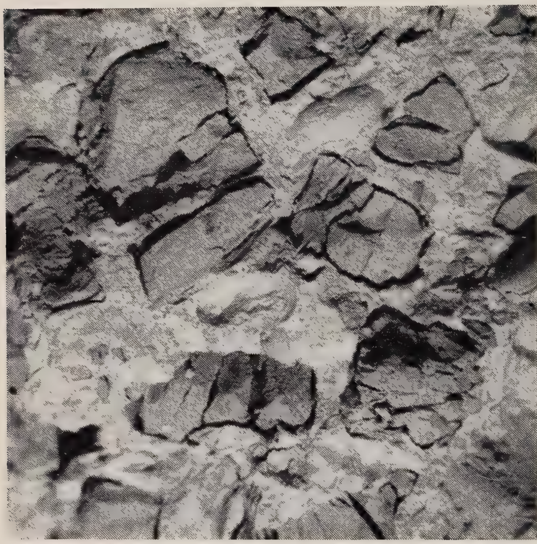

Figure 9. Angular and rounded blocks of fuller's earth clay embedded in limestone of bed 4 at the Devil's Mill Hopper. Note that there is no definite orientation of the blocks of clay. The clay blocks have shrunk on drying leaving a space around each. This space in the picture appears as a black fringe around the blocks. (Photograph by R. L. Day.)

Intercalated between beds 3, 5 and 7 (which are composed largely of fuller's earth clay), beds 4 and 6 are composed of materials having the appearance of intraformational breccias or conglomerates. These consist mainly of limestone containing angular blocks and rounded balls of the underlying fuller's earth clay as well as grains and pebbles of phosphate.

The limestone contains calcite shells, which were identified by Dr. Harbans Puri as *Pecten acanikos* Gardner and *Carolia floridana* Dall. The angular blocks of fuller's earth clay occur in every conceivable orientation (see Figure 9). It is believed that such a stratum might be the result of the "churning up" of materials during a heavy storm. Sessile barnacles which appear to have been torn from their sub-stratum are numerous in these sediments.

Another feature of interest concerning beds 4 and 6 is that the fossils are still composed of calcite, whereas in beds 3, 5 and 7 (those containing largely fuller's earth clay), all fossils, even though they are rare, occur as impressions or as silicified shells. It is believed that the fuller's earth clay is the source of the silica for the silicification of the fossil shells.

In these limestones of beds 4 and 6 there are many more pebbles and grains of phosphate than in the clays of beds 3, 5 and 7. In Alachua County, wherever similar zones of limestone contain calcite fossils and angular blocks and rounded pebbles of underlying sediments, pebbles and grains of phosphate are more numerous than in the surrounding beds.

Thin sections of this limestone show included phosphate grains, clay pellets, orthoclase, plagioclase and microcline. No indications of replacement were seen. The feldspars appear to be clastic.

Discussion of the Hawthorne Formation in Alachua County

Distribution and Outcrops of the Hawthorne Formation. The Hawthorne formation occurs throughout much of the central and all of the northern and northeastern parts of Alachua County. Figure 10 shows sections through the plateau area.

Because all of Alachua County is covered by sands of uncertain age, it is almost impossible to find outcrops of the Hawthorne formation except in road cuts or sink holes. Such outcrops of the Hawthorne are most numerous in the northwestern part of Alachua County and west, south and southeast of Gainesville.

Types of Sediments. The dominant sediments comprising the Hawthorne beds in Alachua County consist of quartz sand, clay, carbonate, and pebbles and grains of phosphate.[4] The proportions

[4] The phosphate in the pebbles and grains of phosphorite occurs as fluorapatites (Vernon, 1951: 200).

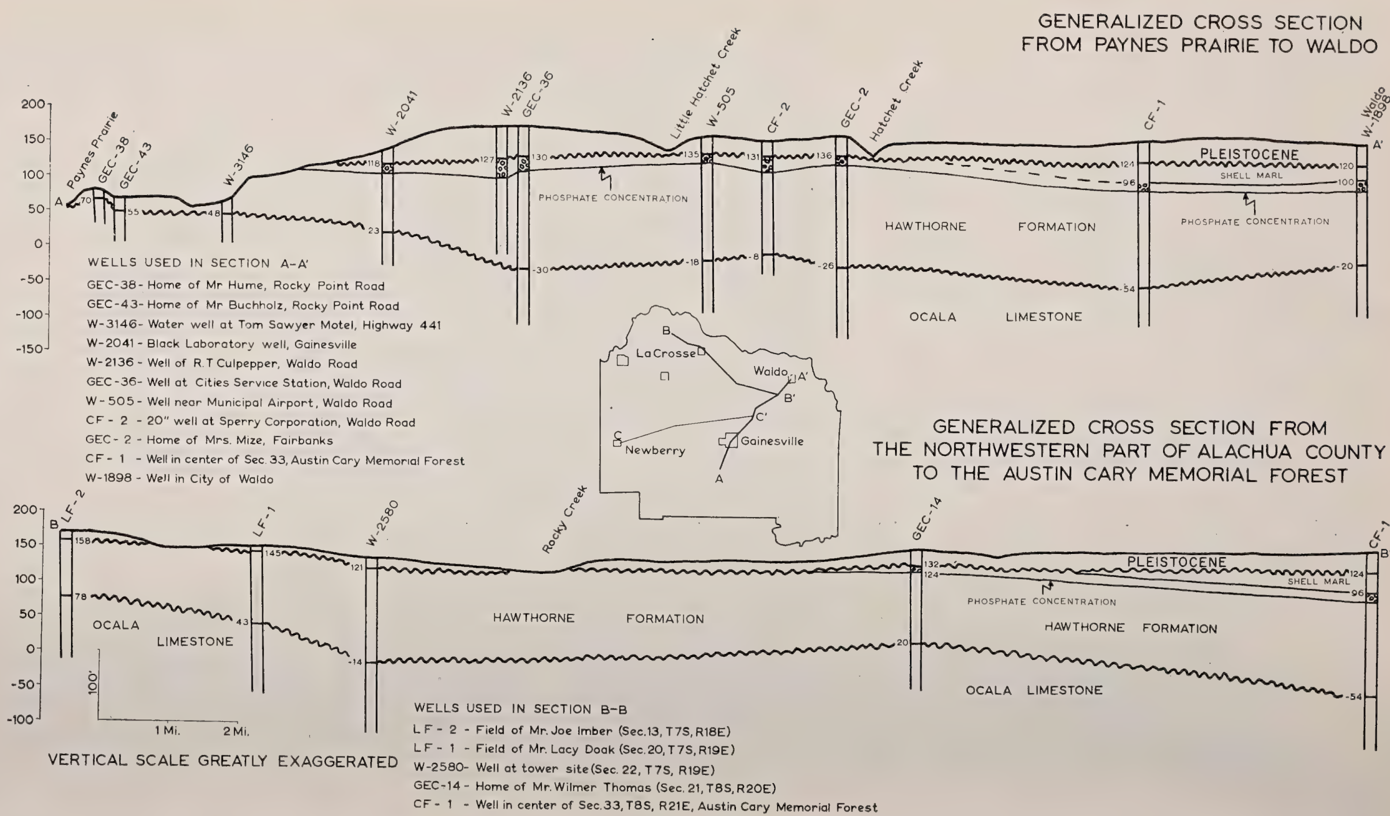
GENERALIZED CROSS SECTION
FROM PAYNES PRAIRIE TO WALDO
PLEISTOCENE
SHELL MARL
PHOSPHATE CONCENTRATION
HAWTHORNE FORMATION
OCALA LIMESTONE
WELLS USED IN SECTION A-A'
GEC-38 - Home of Mr Hume, Rocky Point Road
GEC-43 - Home of Mr Buchholz, Rocky Point Road
W-3146 - Water well at Tom Sawyer Motel, Highway 441
W-2041 - Black Laboratory well, Gainesville
W-2136 - Well of R.T Culpepper, Waldo Road
GEC-36 - Well at Cities Service Station, Waldo Road
W-505 - Well near Municipal Airport, Waldo Road
CF-2 - 20" well at Sperry Corporation, Waldo Road
GEC-2 - Home of Mrs. Mize, Fairbanks
CF-1 - Well in center of Sec. 33, Austin Cary Memorial Forest
W-1898 - Well in City of Waldo
GENERALIZED CROSS SECTION FROM
THE NORTHWESTERN PART OF ALACHUA COUNTY
TO THE AUSTIN CARY MEMORIAL FOREST
LaCrosse
Waldo
Newberry
Gainesville
VERTICAL SCALE GREATLY EXAGGERATED
WELLS USED IN SECTION B-B
LF-2 - Field of Mr. Joe Imber (Sec.13, T7S, R18E)
LF-1 - Field of Mr. Lacy Doak (Sec.20, T7S, R19E)
W-2580 - Well at tower site (Sec. 22, T7S, R19E)
GEC-14 - Home of Mr. Wilmer Thomas (Sec. 21, T8S, R20E)
CF-1 - Well in center of Sec.33, T8S, R21E, Austin Cary Memorial Forest

Figure 10.

of these materials vary from bed to bed and, in cases, even within a few feet both horizontally and vertically in individual strata. The carbonate in some places is largely calcitic and in others dolomitic. Occasionally, lenses of nearly pure clay or sand are found. Individual beds and lenses vary in thickness from less than a foot to 30 feet.

In this study, two types of materials are interpreted as Hawthorne sediments. One comprises the clays, sands, and limestones of the main body of the Hawthorne, and the other, a concentration of phosphate pebbles and grains above this main body. Materials of both these types are present in Dall's type locality for the Hawthorne, and were referred to specifically by Dall.

Fauna and Age. In Alachua County, the main body of the Hawthorne formation is of marine origin and ranges in thickness from a few feet (where most of the formation has been eroded away) up to approximately 175 feet. It thickens in general to the northeast. Sediments in northwestern Florida believed to be contemporaneous were termed the "Alum Bluff group" by Cushman and Ponton (1932), Smith (1941), Vernon (1942), and Cooke (1945). The "Alum Bluff" lies stratigraphically between the Tampa limestone (Lower Miocene) and Choctawhatchee formation (Late Middle Miocene and/or Upper Miocene) (Puri 1953b: 16).

Because no Tampa limestone has been identified in Alachua County and terrestrial vertebrate fossils of Lower Miocene age are known from the area, it seems probable that the region was land during Lower Miocene time. With the advance of the Hawthorne seas, sediments of Middle Miocene age were laid down. These sediments, which constitute the main body of the Hawthorne formation, are covered in Brooks Sink in Bradford County by a shell marl which has been dated by Dr. Harbans Puri on the basis of micro-fauna as of lower Choctawhatchee age.

The concentrations of pebbles and grains of phosphate at the top of the main body of the Hawthorne are believed to have originally accumulated in shallow marine waters during Hawthorne time. Some of these phosphatic sediments have been reworked in post-Hawthorne time by rainwash and streams.

The Hawthorne formation in Alachua County contains numerous molds and casts of marine fossils. Most of the fossils are so poorly preserved that identification is possible in only very few cases.

Lenses of silicified *Ostrea normalis* Dall, a characteristic fossil of the Hawthorne, are found in a number of exposures of Hawthorne sediments. Good exposures of lenses bearing this fossil are as follows:

(a) In Gainesville, on the south side of NW 23rd Road, approximately ½ mile west of the home of Mr. W. A. Shands. This is the only occurrence known in Alachua County in which the shells in the lens are composed of calcium carbonate. As many of the fossils contain both valves together, it is assumed that they have not been transported far. Thus, the occurrences of such fossils in lenses in other localities, even though the shells might be silicified, are believed to represent primary deposition.

(b) On the west side of State Road 241, 1.05 miles south of the Santa Fe River. Approximately NW¼, Section 34, T. 6 S., R. 18 E.

(c) Along the south bank of the Santa Fe River, just west of a dirt road which leads to Brooker. The location is approximately in the NE¼ of the SW¼, Section 14, T. 7 S., R. 19 E.

(d) On the south side of State Road 236, 4 miles west of its intersection with State Road 241. Section 19, T. 7 S., R. 18 E.

(e) One mile south of the Newberry Highway along the north side of an east-west dirt road. The location is ¼ mile west of the intersection of dirt roads which cross in the southeast corner of Section 6, T. 10 S., R. 19 E.

(f) On the west side of the new truck cut-off southeast of Gainesville, about 1.2 miles northeast of the intersection of State Roads 329 and 25. Section 17, T. 10 S., R. 20 E.

Silicified colonies of the coral *Siderastraea* sp. are common in many areas in the northwestern part of the county. Masses of corals, some several feet in diameter, are found north of the town of Alachua, near Traxler and especially in the area bounded by the Santa Fe River and State Roads 25, 236 and 241. These coral heads have been observed only in residual mantle developed on the Hawthorne.

Weathering. Some of the fresh soft sandy clays and especially the clayey sands of the Hawthorne contain abundant soft white grains of phosphate mixed intimately with the sand and in the clay. It may be that as chemical weathering alters these clayey sands, a phosphatic clay develops due to chemical or physical reactions involving the soft phosphate grains and the clay. In cases, the resulting phosphatic clay may act as a binding material for the sand grains, forming a sandstone.

Further weathering reduces this sandstone to arenaceous pebbles which at times have a porous structure or are characterized by rounded openings, see Cooke (1945: 145). Cooke believes

these openings are due to the weathering of phosphate grains and pebbles.

Further weathering reduces these arenaceous, vugy pebbles to loose sand. Many of the Hawthorne clays, which when fresh are normally some shade of gray, are oxidized to yellowish and reddish colors during the weathering.

Summary of the Hawthorne Formation

In review, the main body of the Hawthorne is composed of sands, clays and limestones. It accumulated under shallow marine conditions and is Middle Miocene in age. The individual beds are highly variable in lithology both laterally and vertically. In many localities at the top of this main body is a concentration, ranging up to 40 feet in thickness, of pebbles and grains of phosphate embedded in a matrix composed of various combinations of clay, sand and carbonate. Dall, in his original description of the Hawthorne, included all of these materials in his "Hawthrone beds." Taken together they constitute a mappable unit even though in some areas the top phosphate concentration might be re-worked material of later age.

Alachua Formation

Various Interpretations of Alachua Sediments

The name "Alachua clays" was used in 1885 and published in 1892 by Dall (Dall and Harris, 1892: 127). The terms "Alachua clays" and "Alachua formation" have been applied to sediments of various types and ages. The situation can best be illustrated by the cross-section, Figure 11, considered in connection with quotations from previously published writings with brief comments concerning the interpretations.

Dall (1892: 127) described as his "Alachua clays" the "Clay containing bones of extinct mammalia," see "4" on the lower cross-section of Figure 11. Dall further stated, "These clays occur in sinks, gullies, and other depressions in the Miocene, Upper Eocene, and later rocks of Florida, especially on the western anticline in the higher portions of Alachua County, and along banks of many rivers and streams . . . The clays occur in patches, usually in depressions, but occasionally in short ridges whose lateral buttresses of limerock have disappeared through the dissolving agency of rainwater and carbon dixoide."

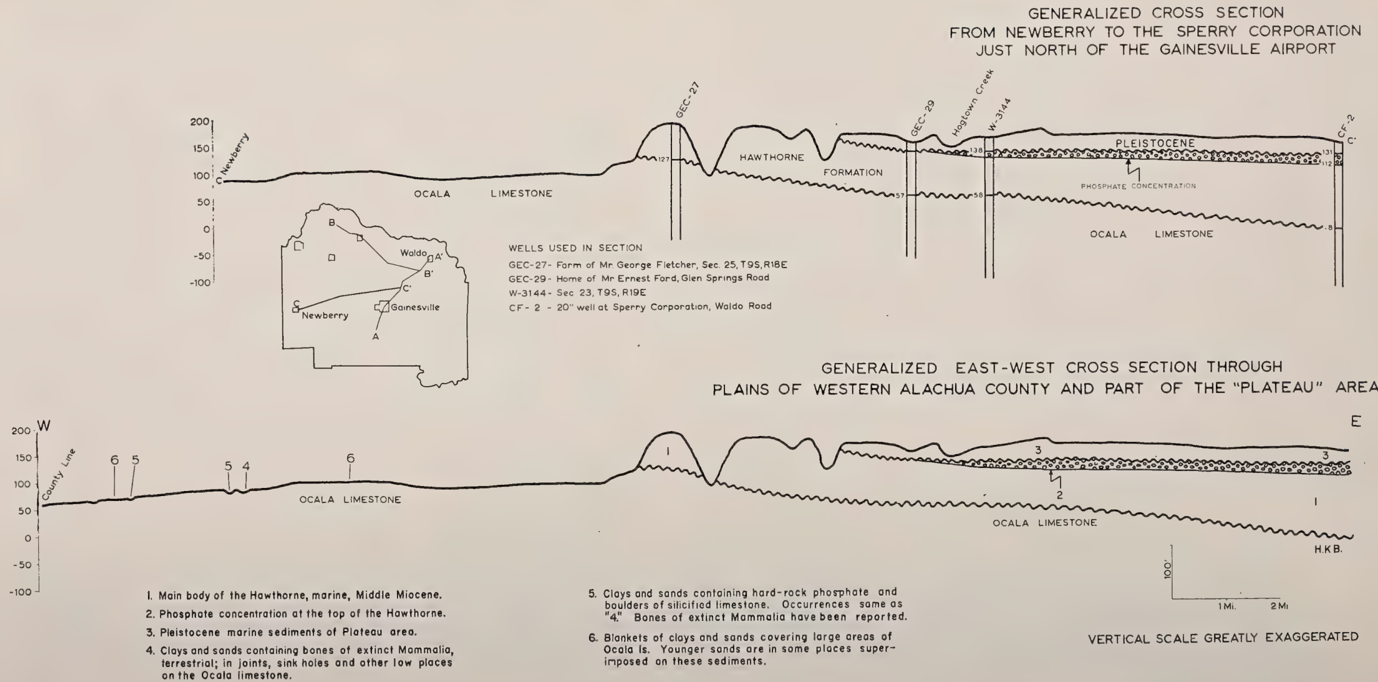
GENERALIZED CROSS SECTION
FROM NEWBERRY TO THE SPERRY CORPORATION
JUST NORTH OF THE GAINESVILLE AIRPORT
Newberry
C
GEC-27
GEC-29
Hogtown Creek
W-3144
CF-2
C'
200
150
100
50
0
-50
-100
OCALA LIMESTONE
HAWTHORNE FORMATION
PLEISTOCENE
PHOSPHATE CONCENTRATION
OCALA LIMESTONE
127
57
138
58
131
112
8
B
Waldo
A'
B'
C'
Newberry
Gainesville
A
WELLS USED IN SECTION
GEC-27- Farm of Mr. George Fletcher, Sec. 25, T9S, R18E
GEC-29- Home of Mr Ernest Ford, Glen Springs Road
W-3144- Sec 23, T9S, R19E
CF- 2 - 20" well at Sperry Corporation, Waldo Road
GENERALIZED EAST-WEST CROSS SECTION THROUGH
PLAINS OF WESTERN ALACHUA COUNTY AND PART OF THE "PLATEAU" AREA
W
E
County Line
6 5
5 4
6
1
3
2
3
1
OCALA LIMESTONE
OCALA LIMESTONE
H.K.B.
100'
1 Mi.
2 Mi
VERTICAL SCALE GREATLY EXAGGERATED
1. Main body of the Hawthorne, marine, Middle Miocene.
2. Phosphate concentration at the top of the Hawthorne.
3. Pleistocene marine sediments of Plateau area.
4. Clays and sands containing bones of extinct Mammalia, terrestrial; in joints, sink holes and other low places on the Ocala limestone.
5. Clays and sands containing hard-rock phosphate and boulders of silicified limestone. Occurrences same as "4." Bones of extinct Mammalia have been reported.
6. Blankets of clays and sands covering large areas of Ocala ls. Younger sands are in some places superimposed on these sediments.

Figure 11.

Dall's main localities of "Alachua clays" represent such sediments accumulated in depressions of the Ocala limestone. Some of his other localities apparently do not represent such occurrences. His clays just west of Gainesville are for the most part Hawthorne sediments, "1" on Figure 11. It is believed that his localities just north of Gainesville would correspond to "2" on the figure. Dall considered river pebble phosphate as "Alachua."

Although Dall in citing occurrences of his "Alachua clays" included a number of different types of deposits, it is quite clear that he considered as his "Alachua clays" terrestrial accumulations occurring in joints, sink holes and other low places in the Ocala limestone especially along the breached arch of the Ocala uplift in western Alachua County. Such sediments, generally covered by sands of Pleistocene age, represent in part a residuum in situ of various post-Eocene materials often mixed with boulders of Ocala limestone, and in part materials transported by rain-wash and streams to low areas such as sinks and shallow lake basins.

Dall considered these accumulations, some of which contain fossil remains of land vertebrates, as Pliocene in age. Later studies have shown that some such accumulations are of Pliocene age, but that others are of Early Miocene age, and many of Pleistocene age. A number of workers have considered the land vertebrate fossils found in individual deposits to represent mixed faunas. During the past several years Drs. Pierce Brodkorb and Walter Auffenberg of the University of Florida and Dr. Robert S. Bader formerly of the University of Florida have located many new occurrences of vertebrate fossils in such terrestrial sediments. Land vertebrates from certain previously described areas have been restudied. The work carried on by these men indicates that the fossils in individual deposits in general do not represent mixed faunas.

Sellards (1910: 32) originally called sediments which occurred in sinks and low areas in underlying limestone and which contained hard-rock phosphate the "Dunnellon formation" from a locality near the town of Dunnellon in Marion County where such sediments occur. Similar sediments are represented on Figure 11 as "5." Later Sellards recognized that these sediments were the same as the clays containing extinct Mammalia found in sink holes in the same general area (Figure 11, occurrence "4"). Thus,

Sellards concluded that the sediments of the hard-rock phosphate deposits were a part of the Alachua formation and recommended that the name "Dunnellon formation" be dropped. The inclusion of the deposits containing hard-rock phosphate in the Alachua formation greatly expanded the original use of the term "Alachua clays."

Simpson (1930) in a stimulating discussion attempted to restrict the Alachua to terrestrial sediments accumulated during the Pliocene. He considered the first occurrences listed by Dall as the type Alachua. Such occurrences, indicated by "4" on the figure, were thought by Simpson to be of Pliocene age.

Cooke (1945: 199) considers the Alachua formation as Middle Pliocene in age and in giving his opinion of the formation, states, "The Alachua is unique among geologic formations in Florida in that most of it was not deposited in water, either salt, or brackish, or fresh. The bulk of the Alachua is merely the collapsed and compacted residue of the Hawthorn formation *in situ* together with accumulations in sinkholes and ponds. These latter accumulations contain the bones of Pliocene animals." Such sediments would be represented on Figure 11 by "4," "5" and "6." Cooke states that the clays northwest of Gainesville are Alachua. Most clays northwest of Gainesville belong to the main body of the Hawthorne, contain lenses of undisturbed *Ostrea normalis* Dall and would be represented as "1" on the diagram.

Vernon (1951: 190) in a report on Citrus and Levy counties used the term "Alachua formation" in reference to those counties to include "terrestrial deposits of diverse lithologic characteristics, but composed largely of clays, fine sands and a basal rubble of phosphate rock, silicified wood, clay beds, and silicified Suwannee and Ocala limestone residuum. The sediments rest upon a bed rock of limestone ranging in age from middle Eocene to Oligocene except in southern Citrus County, where they interfinger with, and, in part, lie upon the Hawthorn formation." Vernon states that the sediments of the Alachua formation contain vertebrates which range in age from lower Miocene into Pleistocene. He believes the formation may have accumulated not only throughout the Miocene epoch but also during the period extending into the Pleistocene. Vernon (loc. cit.: 195) further states, "The formation is believed to be in part contemporaneous with the Hawthorn formation and in part of younger age. It was formed on

uplands and as a rule overlies the Hawthorn formation, but in some wells occupies the stratigraphic position of the Hawthorn."

Vernon states that the Hawthorne formation never was deposited over some areas which contain hard-rock phosphate and in his Figure 33 (loc. cit.: 180) indicates that the Hawthorne formation was not deposited over the Ocala uplift area. Thus, one would assume that Vernon does not consider sediments of the Alachua formation which contain hard-rock phosphate as the collapse and compacted residue of the Hawthorne formation in situ.

Vernon apparently considers phosphate concentrations at the top of the Hawthorne such as those north of Gainesville and throughout the northeastern part of Alachua County as Alachua. Such materials are labeled as "2" on Figure 11 and in this report are considered as a part of the Hawthorne formation. Dall referred specifically to such a phosphate concentration as Hawthorne in the type area of the Hawthorne. Vernon's proposals would tend to make the Alachua formation more encompassing than any previous concept.

Types of Sediments

In Alachua County the materials composing what has been called the Alachua formation are largely combinations of sand and clay. In some of the sediments silicified boulders of limestone, most of which are Ocala, are common. Plates, grains, pebbles and boulders of phosphate ranging up to masses several feet in diameter are present in some of the occurrences. The plates and boulders of phosphate, extensively mined in the early 1900's, are known in industry as hard-rock phosphate. Some of the clay is phosphatic and constitutes the material called soft-rock phosphate.

The hard-rock phosphate is a secondary type deposit. Phosphate leached by ground water from phosphatic pebbles and grains of the Hawthorne formation has been carried down to fill openings and to replace Ocala limestone fragments. Thin sections of phosphatized Ocala limestone have revealed micro fossils of the Ocala. Such secondary phosphatic sediments are genetically associated with the Alachua formation.

In some areas of Alachua sediments remnants of the Hawthorne formation occur which contain phosphatic particles of the type known in industry as pebble phosphate. These phosphatic sedi-

ments represent materials from which the phosphorus has not yet been leached out by ground water. Many are believed to have formed as discrete individual accretionary aggregates in a marine environment and are syngenetic with the Hawthorne formation.

Problems Concerning the Alachua Formation

A few examples will demonstrate that terrestrial sediments containing bones of land vertebrates of Lower Miocene, Pliocene and Pleistocene ages are present in Alachua County.

A fauna, discussed by Simpson (1932), from the southwest side of the hard-rock phosphate pit number 2 (Section 31, T. 9 S., R. 17 E.) of the Franklin Phosphate Company near Newberry included the following fossils: *Temnocyon?* (dog), *Parahippus* or *Archaeohippus* (horse), *Caeopus?* or *Diceratherium* (rhino), *Dinohyus,* which is probably a subgenus of *Daeadon* (early pig-like form), camelids (camels), and *Blastomeryx?* (deer). In a personal letter reviewing the Alachua fauna, H. H. Winters stated in regard to this locality, "Eliminating the questionable forms, the horse and pig are left. Both *Parahippus* and *Archaeohippus* range through the Miocene: *Dinohyus* hasn't been found later than early Miocene and in fact seems to be limited to that span of time. The questionable *Temnocyon* and genus of rhinoceros, whichever it is, point to a pre-Middle Miocene age."

Even though located outside of Alachua County, one occurrence of terrestrial sediments containing vertebrate fossils should be mentioned. This occurrence, on the Raeford Thomas farm 8 miles north of Bell in Gilchrist County (and approximately 12 miles west of Alachua County), is one of the best localities for collecting land vertebrates in the eastern United States. Vernon (1951) indicated that this site is an example of a terrestrial deposit containing land vertebrates ranging in age from Lower Miocene through Upper Miocene. In a recent study, Bader (1956) concludes that there is no evidence to indicate a mixing of fauna in this occurrence. He considers the fauna to be Lower Miocene in age and thus is in agreement with White (1942: 31-32) and Romer (1948: 6) who had earlier arrived at this same conclusion.

Many Pliocene vertebrate land fossils have been reported from the Alachua formation in the county. Simpson (1930: 176) considers the following Pliocene mammals to be indigenous to the Alachua formation.

Hipparion ingenuum Leidy. Horse
H. plicatile (Leidy). Horse
H. minor Sellards. Horse
Teleoceras proterus (Leidy). Rhinoceros
Aphelops longipes (Leidy). Rhinoceros
Megatylopus? major (Leidy). Camel
Procamelus? minor (Leidy). Camel
P. minimus (Leidy). Camel
Serridentinus floridanus (Leidy). Mastodon
S. leidii (Frick). Mastodon

Numerous occurrences of land vertebrates of Pleistocene age have been found in stream beds and in terrestrial deposits of sand and clay which occur in pockets and sinks in the Ocala limestone in the western and south-central parts of Alachua County. Brodkorb (1957) has shown that these deposits containing only Pleistocene fauna frequently are covered by orange-tan clayey sand which he believes to be of marine origin. This orange-tan sand is found in many parts of south-central and western Alachua County and in the past often has been considered as part of the Alachua formation. Brodkorb has studied in detail one of these terrestrial Pleistocene occurrences (Arredondo, No. 2 below) and has given evidence, some of which is based on the nature of the associated bird fauna, that the vertebrates in that locality lived during a glacial stage and are embedded in fresh water clay. Such clay contains numerous remains of frogs and salamanders, forms which do not live in salt water.

From information supplied by Dr. Pierce Brodkorb, two Pleistocene occurrences were selected and the Pleistocene indicators of each fauna are listed below.

1. Sand and clay occurring in solution depression in Ocala limestone. Exposed in quarry near Haile (Section 24, T. 9 S., R. 17 E.).

   Class Mammalia
   Dasypus bellus (Simpson). Armadillo
   Holmesina septentrionalis (Leidy). Giant armadillo
   Aenocyon ayersi (Sellards). Dire wolf
   Equus sp. Horse
   Platygonus sp. Peccary
   Tapirus veroensis Sellards. Tapir
   Smilodon sp. Sabertooth

Class Aves
- Accipitridae. Eagle
- Corvidae. Magpie-jay

2. Clay in solution pits in Ocala limestone. Exposed in quarry northeast of Arredondo, approximately 6 miles southwest of Gainesville (NW¼ of Section 22, T. 10 S., R. 19 E.).

Class Mammalia
- *Dasypus bellus* (Simpson). Armadillo
- *Synaptomys australis* Simpson. Lemming mouse
- *Tapirus veroensis* Sellards. Tapir
- *Equus* sp. Horse
- *Tanupolama mirifica* Simpson. Camel

Class Aves
- *Colinus* sp. Pleistocene quail
- *Tachycineta* sp. Cave swallow
- Icteridae. Pleistocene oropendola

Class Reptilia
- *Testudo sellardsi* Hay. Large tortoise
- *Terrapene canaliculata* Hay. Box turtle

Class Amphibia
- *Pseudobranchus robustus* Goin and Auffenberg. Salamander

From the preceding examples of fauna found in terrestrial deposits, it appears that the western part of the county was land at least at times during Lower Miocene, Pliocene, parts of the Pleistocene, and Recent.

If all materials which represent residuua formed at various times and which have accumulated along joints, in sinks and other low places in the Ocala limestone and if, in addition, sediments shifted by rainwash or streams into low areas of the Ocala are classed as Alachua, the formation loses time significance. Materials being transported by rainwash and streams into shallow lakes, sink holes, and other low areas of the Ocala today would fit the physical characteristics of the so-called Alachua. These terrestrial sediments constitute a problem.

1. Should the sediments which accumulated under terrestrial conditions during each of the epochs be given separate names?

2. Should all these materials be lumped together and called a formation?
3. Is any of the material deserving of formational rank?

It is entirely probable that for the present no attempt to work out a satisfactory solution for the Alachua will meet with general approval and acceptance.

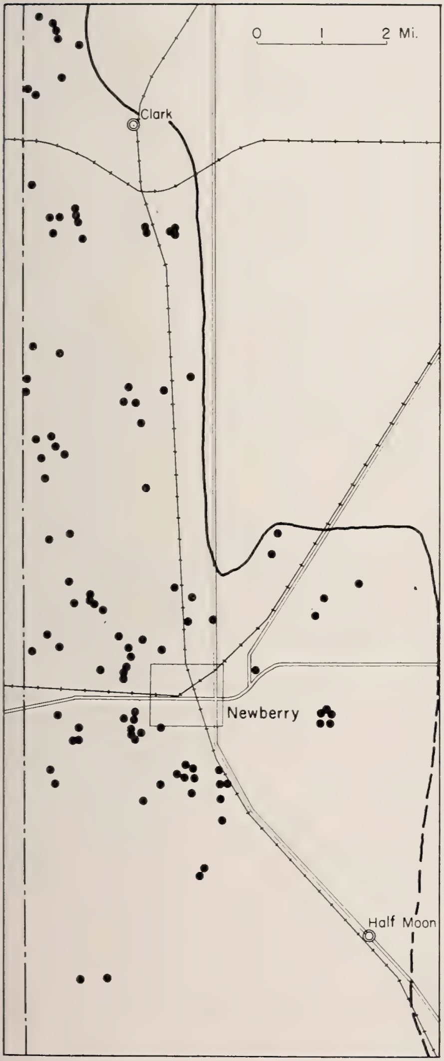

Figure 12. Location of abandoned hard-rock phosphate pits.

Hard-rock Phosphate

The so-called Alachua formation contains the hard-rock phosphate of Alachua County. Figure 12 shows the locations of old hard-rock pits in the county. Sellards (1913) and most later workers consider that the phosphate of the hard-rock deposits originally occurred as grains in the Hawthorne formation. Such grains were dissolved by downward percolating rain water and reprecipitated as calcium phosphate by reaction with the underlying limestone bedrock.

Vernon (1951) disagrees with these ideas and revived the bird rookery theory to account for most of the phosphate of the hard-rock deposits as well as to account for at least some of the phosphate in the Hawthorne formation. According to Vernon, if the phosphate of the hard-rock

deposits was derived from the erosion of the Hawthorne as postulated by Sellards and Cooke, a source for the Hawthorne phosphate would still be undetermined. But birds living in colonies in the area of the Ocala uplift during the Miocene would provide a ready source of phosphorite during the Miocene.

Several lines of evidence gathered during this study indicate that the Hawthorne formation covered the western part of Alachua County and thus could have served as the immediate source for the phosphate in the hard-rock deposits of the Alachua formation.

1. In drilling a number of wells in western Alachua County, materials were penerated which are believed to represent Hawthorne sediments. One example is furnished by a water well completed July 7, 1955 at the home of Mr. Hopper Gravely (NE¼, SW¼, Section 2, T. 10 S., R. 17 E.) about 1½ miles east of Newberry. This well, with a surface elevation of 85.90 feet, is mentioned specifically because it is located in an area where hard-rock phosphate is known to occur in the Alachua formation. Also, the locality is west of pits from which hard-rock phosphate has been mined.

   Ocala limestone was encountered in the well at a depth of 34 feet. In the interval between 5 and 20 feet, the sediments consisted mainly of clay ranging in color from a yellowish (ochre) tint to greenish gray. Embedded in the greenish gray clay were numerous soft, white phosphate grains. This clay with the included soft, white phosphate appears identical to the clay encountered at a depth of 21-30 feet in hole No. 1 drilled on the property of Mr. Roy Brown in the type locality area of the Hawthorne formation. Clay of the same appearance with the included soft, white phosphate grains has been found in a number of other localities where undisturbed lenses of *Ostrea normalis* Dall are known to occur. An example of such an occurrence is furnished by exposures on the new truck cut-off southeast of Gainesville.

2. The physiographic relationships of the plateau to the plains (see Figure 11) suggest that formations in the plateau at one time also covered the plain in western Alachua County. This plain has been developed as a result of the breaching

of the Ocala uplift. The break between the plateau and the plain, which occupies the center of the arch, represents a retreating escarpment with occasional outliers on the plain.

As degradation proceeded after uplift, the overlying formations, mainly the Hawthorne, were weathered and eroded and the Ocala limestone approached. This initiated a stage of subsurface drainage and karst development at the center of the arch. Further development has resulted in subduing the karst relief and the development of a plain. This plain has been modified by the gradational work of Pleistocene seas.

Some of the ridges found along the boundary between the plain and the plateau show exposures containing the characteristic Hawthorne fossil, *Ostrea normalis* Dall. In one outlier, completely isolated from the plateau, a lens of these fossils was located.

3. Cross sections constructed from the plateau area across the plains of Alachua County furnish strong evidence that the Hawthorne at one time covered a considerable area west of the present plateau. One such section is shown in Figure 11.

In summary, on the basis of information from drill hole cuttings in which sediments were encountered which appear identical to certain Hawthorne materials, from the physiographic relationships of the plateau to the plains, and from the study of cross sections, it is believed that the Hawthorne formation covered the plain in western Alachua County. Since the Hawthorne formation covered that area of Alachua County in which hard-rock phosphate has been mined from the Alachua formation, because the Hawthorne formation contains tremendous quantities of phosphate, and as replacement of limestone by phosphate dissolved from the Hawthorne can be demonstrated, the Hawthorne is considered as the immediate source for most of the phosphate in the hard-rock deposits of the Alachua formation.

Those areas containing large quantities of hard-rock phosphate can be delimited. As the Hawthorne is Middle Miocene in age, phosphate which replaced the Ocala limestone or which was precipitated in openings in that limestone forming the hard-rock deposits would be post-Hawthorne in age. Such deposits normally

are covered by sands of Pleistocene age. It is probable that most of such "Alachua sediments" containing hard-rock phosphate are post-Hawthorne and pre-Pleistocene in age (Late Miocene or Pliocene). This does not preclude some of the limestone fragments now replaced by phosphate having accumulated in sinks prior to Hawthorne time, and being replaced by phosphate in post-Hawthorne time. Nor should it be considered that formation of hard-rock phosphate from the weathering and erosion of the Hawthorne could not have continued in places during parts of the Pleistocene.

Summary of the Alachua Formation

In Alachua County the materials which have been called Alachua consist of terrestrial deposits which accumulated at intervals during Early Miocene, Pliocene and Pleistocene times. Some of these materials represent residuum of post-Eocene formations (mainly the Hawthorne) often mixed with boulders of silicified Ocala limestone accumulated in situ. Other parts represent sediments shifted by rainwash and streams into sinks, shallow lakes and other low areas of the Ocala limestone. The Alachua formation should be restricted to the plains area and the more highly dissected parts of the plateau.

The terrestrial vertebrate fossils found in individual deposits in general are not believed to represent mixed faunas. It is impossible to map faunal zones in materials presently designated and mapped as Alachua. The age of a horizon or site of these materials is known only when vertebrate fossils are found. Though sometimes abundant, fossil remains occur only sporadically. Because horizons can not be traced for any distance laterally, it seems impractical to propose time-stratigraphic divisions of the Alachua for the purpose of mapping.

The concentrations of pebbles and grains of phosphate at the top of the Hawthorne should not be considered as Alachua sediments. Similar materials at the old Simmons' pits were called Hawthorne by Dall and thus are Hawthorne by definition.

Post-Hawthorne Sediments of the Plateau Area

Gray, red and yellow clayey sands and sandy clays cover the Hawthorne formation in the area of the town of Hawthorne. Be-

cause these sediments, which are post-Hawthorne in age, often have been considered as a part of the Hawthorne formation, it is considered desirable to discuss them briefly.

Figure 13. Exposure of post-Hawthorne sediments on west side of Highway 301, 1.85 miles south of Orange Heights, showing loose, whitish sand overlying clayey sand. The irregular contact, shown in the central part of the picture, has the appearance of an unconformity. It has not been determined whether two formations are represented or whether the loose sands have resulted from the downward migration of clay. The latter seems far more probable. Such clayey sands often are various shades of red and yellow due to oxidation of iron compounds in the clay.

Throughout northeastern and east-central Alachua County there are many exposures of gray, clayey sands and sandy clays which commonly have a mottled red and yellow appearance and in cases are dominantly yellowish or reddish in color. In places elongated to discoid-shaped quartz pebbles are common to abundant in the sediments. From one to five feet of loose surface sand of a white to tan color blankets these clayey sands and sandy clays (Figure 13).

These materials are best exposed in an eastward-facing cut along the western side of Highway 301 between the towns of Hawthorne and Orange Heights. The sediments are stratigraphically younger than the shell marl of Choctawhatchee age (late Middle Miocene and/or Upper Miocene) exposed in Brooks Sink.

The 1945 Geologic Map of Florida published by the Florida State Geological Survey shows an area north of Gainesville covering at least 10 square miles which is mapped as thick sands of Pleistocene age. In drilling wells throughout this area, it is found that typically there is a cover of loose sand of variable thickness below which is sand with a clay binder between the grains, the clay content in general increasing with depth.

Figure 14 is a photograph of 23 feet of these sediments exposed in a canal just north of the Gainesville Airport. There the post-Hawthorne materials overlie unconformably two or three feet of a phosphate concentration of the Hawthorne formation. The post-Hawthorne sediments are mostly white to tan, loose to slightly indurated sand. In the lower part of these sands, blocks or slabs of gray clay occur, and discoid-shaped quartz pebbles are numerous. It may be that these slabs of clay represent a more continuous clay stratum which was broken up by waves and in places further deformed by the weight of the overlying sediments.

Along the same canal, not more than a few hundred feet from the section shown in the photograph and at the same elevation, sediments beginning within a few feet of the surface have a mottled red and yellow appearance and look identical to the red and yellow sediments found in northeastern Alachua County. At the new Sperry plant just a few hundred yards north of this canal, mottled red and yellow clayey sand was encountered in drilling at a depth of seven feet. In drilling water wells in the "thick" sand area north of Gainesville, some holes penetrate as much as 25 or 30 feet of loose sand, whereas other holes nearby encounter the red and yellow sediments practically at the surface. Data

Figure 14. Post-Hawthorne sediments overlying unconformably a heavy concentration of pebbles and grains of phosphate of the upper Hawthorne. The top of the phosphate concentration in the lower part of the picture is indicated by the hammer held in hand. Blocks and slabs of clay occur in the lower parts of the post-Hawthorne sediments. Exposure along a canal dug in 1942 north of the Gainesville airport to divert one of the tributaries of Hatchet Creek around the landing strip. (Photograph by R. L. Day.)

gathered during this study indicates a strong possibility that, with the possible exception of the thin layer of loose surface sand, these sediments in the "thick" sand area north of Gainesville and the red and yellow clayey sands and sandy clays of northeastern and east-central Alachua County grade into each other.

These materials north of Gainesville and throughout northeastern and east-central Alachua County range in thickness from a few feet to 45 feet and in general thicken toward the east and northeast and thin over the Hawthorne formation to the west. There is a marked unconformity between these sediments and the underlying material which usually is the Hawthorne but in a few places is the shell marl of Choctawhatchee age.

There is no complete agreement as to the origin or age of these post-Hawthorne sediments. Some workers have indicated the belief that some of the materials are residual from the Hawthorne formation. Others have considered the red and yellow clayey sands and sandy clays as part of the Hawthorne formation of Middle Miocene age. In areas where there is more or less of a concentration of quartz pebbles, the sediments have been called Citronelle of Pliocene age and considered to be a littoral deposit. Other workers consider the thick sands north of Gainesville as Pleistocene in age and of marine origin. However, MacNeil (1950: 99) states that there is no proof that the Pleistocene seas ever rose to elevations over 150 feet above present sea level and expressed his belief that terrace sands above that elevation are of sub-aerial origin.

The sediments are too uniform in character to represent alluvial or residual materials. Rare small, poorly preserved marine fossil pelecypods have been found in place in the thick sands along the canal north of the Gainesville Airport. Dr. R. A. Edwards has accompanied the writer and verified the occurrence of the fossils in place. No reference has been found in the literature to fossils from these thick sands. In a personal letter dated March 24, 1954 regarding these pelecypods, Dr. Harbans Puri stated that the fossils represent "a typical inner neritic molluscan fauna." Since it is believed that much of the "thick" sand north of Gainesville and the red and yellow clayey sands and sandy clays in northeastern and east-central Alachua County grade into each other, it is considered that these post-Hawthorne sediments all are marine in origin.

Exact dating of these sediments awaits further detailed areal studies. The materials are post-Choctawhatchee in age and are believed to be Pliocene or Pleistocene. A Pleistocene age is considered far more likely.

Outline Summary of Some Important Events in the Post-Ocala History of Alachua County

1. All post-Ocala sediments in Alachua County lie unconformably over the Ocala limestone.
2. At least a part of western Alachua County was invaded by marine waters during Oligocene time resulting in the deposition of the Suwannee limestone. This is evidenced by hundreds of residual boulders of that limestone containing the characteristic fossil, *Cassidulus gouldii* (Bouvé). It is possible that Suwannee limestone is in place in a few small areas north of High Springs.
3. The presence of lower Miocene land vertebrate fossils from western Alachua County suggests that land area existed in the county during Early Miocene.
4. With the possible exception of a few minor areas north of High Springs (where Suwannee limestone may be in place), Middle Miocene marine Hawthorne sediments were laid down on an irregular, solution pitted Ocala surface, the nature of which suggests that the Ocala was subjected to sub-aerial weathering and erosion before deposition of the Hawthorne beds. Lenses of undisturbed *Ostrea normalis* Dall have been observed in Hawthorne sediments directly above filled, pre-Hawthorne sink holes developed in the Ocala. If such sinks had developed after the Hawthorne was laid down, the beds of oysters would show the effects of slumpage. In western Alachua County, a number of such occurrences have been noted. This would suggest the possibility that between Suwannee time and Middle Miocene Hawthorne time, the Suwannee limestone was largely eroded away lending more evidence that part of the county was land during Early Miocene.
5. Marine sediments of late Middle Miocene and/or Upper Miocene probably were deposited in northeastern Alachua

County. This is indicated by the presence of a shell marl considered as Upper Miocene by Cooke (1945: 183).

6. The county was land probably during much of Pliocene time. Sediments carrying Pliocene terrestrial vertebrates have been found in a number of localities. For example, sands and clays occurring directly over Ocala limestone near Haile (Section 24, T. 9 S., R. 17 E.) were found by Auffenberg to contain *Hipparion minor* (small 3-toed horse), *Pseudemys caelata* (fresh water turtle) and a giant terrestrial tortoise.

7. During the Pleistocene the county was covered by marine waters at times and was dry land at other times. The "thick" sands north of Gainesville and the red and yellow clayey sands and sandy clays throughout northeastern and east-central Alachua County are believed to represent marine Pleistocene sediments. Marine invertebrate fossils have been found in these materials. Numerous local deposits in depressions containing Pleistocene land vertebrate fossils have been discovered in the county.

Ocala Uplift

According to Vernon (1951), the crest of the Ocala uplift runs in a northwest-southeast direction and is located in eastern Citrus and Levy counties. Western Alachua County is located on the eastern flank of the major uplift. Vernon indicates that the Ocala uplift took place mainly in lower Miocene, though some structural movements may have continued irregularly through later epochs.

It is believed that the major upwarpings which have affected Alachua County during post-Eocene time are associated with the Ocala uplift. The preceding outline summary of some important events in the post-Ocala history of Alachua County indicates such upwarpings during lower Miocene with continuing periodic uplift during later Tertiary times.

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THE PROBABLE LOWEST AVERAGE SALINITY IN THE INDIAN RIVER [1]

FRANK CHEW
University of Miami

INTRODUCTION

The increased demand for agricultural land in the Florida peninsula poses the problem of how best to dispose of the excess gravitational water drained from the soil. The problem is particularly acute along the east coast where there are shallow lagoons with very restricted ocean communications. It is feared that if the drained excess water is passed directly into the lagoons, the salinity will change so drastically that the original faunal regime may be annihilated. A proposal has been presented to drain the upper St. John River and Lake Wilmington by three canals directly into the Indian River, a nontidal broad shallow lagoon with restricted ocean communications at the inlets of Sebastian, Ft. Pierce and St. Lucie. The Florida State Board of Conservation, charged with the responsibility of evaluating the biological consequences of the proposed diversions, desires a knowledge of the probable lowest average salinity of those portions of the Indian River where diversions may be realized. Because of the similarity of the Indian River lagoon to other lagoons along the east coast where there may be other future diversions, the equation for this estimate (which, perhaps, could be written down directly) will be derived through a somewhat general consideration of the salt budget. This has been done in order to gain some insights into the various simplifications and approximations introduced, and so that when applied elsewhere along the east coast, modifications of the equation may be readily made to meet changed conditions.

Evaporation and diffusion (and transpiration in the case of rank plant growth) are pertinent processes that will increase the salinity in a semienclosed basin where tidal current is absent. Processes that will decrease it are precipitation, river and estuarine discharges. A knowledge of these processes together with the amount of salt stored in the basin is sufficient to solve the salinity problem. The attainment, however, of this knowledge requires a comprehensive effort not presently envisaged. In this rudimentary study, these factors will be lumped together into two categories: those

[1] Contribution No. 167 of the Marine Laboratory, University of Miami.

tending to increase and those tending to decrease the salinity. These categories, in conjunction with the somewhat artificial but presently necessary assumption of complete horizontal and vertical mixings and additional assumptions to be introduced later, will lead to an estimate of the desired variable. Three salt budget regimes will be considered: the steady state, the nonsteady state with equal and unequal river and estuarine discharges.

Steady State with Equal River and Estuarine Discharges

The salt content of a basin is in a steady state condition when it does not change with time (and in this special study, does not change with space also). Thus the amount of salt entering into the basin must equal the amount discharged. Under this condition a knowledge of the net amount of salt brought in may be estimated. This is illustrated in the following simple case where estuarine discharge is the only salinity decreasing factor considered. Suppose the basin has a constant volume of 1,000 units and salt in the amount of 20 units; into this basin the river adds 10 units of water weekly. If complete mixing is assumed, the estuarine discharge subtracts from the basin 10(20/1020) or about 0.2 units of salt per week. If the total salt in the basin is constant, diffusion must bring in this same amount of salt from the open ocean.

Non-Steady State with Equal River and Estuarine Discharges

Suppose the salt brought in by diffusion is constant in amount while the river discharge is increased from 10 to 100 units. The estuarine discharge will now take out more salt than is brought in so that the initial steady state is destroyed and the net salt amount in the basin decreases until the amount taken out equals the amount brought in when a new steady state is again attained. A particularly simple equation for this non-steady state may be written if one assumes that the river discharge and the net salt amount brought into the basin are time constants. Let

b=amount of salt brought in

S_0=the net amount of salt in basin prior to increased river discharge

R=the river discharge per unit time, here taken equal to the estuarine discharge

V_o=the total initial water volume in basin and

$k_1=R_1/(V_o+R_1)$, $k_2=R_2/(V_o+R_1+R_2)$, etc.

then the amount of salt, S, left in the basin after one, two and three time units (when complete mixing is assumed) are

$$S_1=S_o(1\text{-}k_1)+b_1 \tag{1}$$

$$S_2=S_o(1\text{-}k_1)(1\text{-}k_2)+b_1(1\text{-}k_2)+b_2 \tag{1a}$$

$$S_3=S_o(1\text{-}k_1)(1\text{-}k_2)(1\text{-}k_3)+b_1(1\text{-}k_2)(1\text{-}k_3)+b_2(1\text{-}k_3)+b_3 \tag{1b}$$

If the k's and b's are separate constants, then equation (1b) simplifies to

$$S_3=S_o(1\text{-}k)^3+b[1+(1\text{-}k)+(1\text{-}k)^2] \tag{1c}$$

After n times units, it is

$$S_n=S_o(1\text{-}k)^n+b[1+(1\text{-}k)+(1\text{-}k)^2+\ldots+(1\text{-}k)^{n-1}] \tag{2}$$

For example, if k is 1/10, S_o is 20 units and b is 2/10 units then after 10 time units, S_{10} is 9.07 units. The new steady state is approximately reached after 50 time units when S_{50} is just over 2 units. It is to be noted that, since b is usually a small fraction of S_o, the first term on the right in (2) contributes the most when n is small and its importance decreases as n increases. If b is zero. S_n will eventually be zero; if k is large, S_n will decrease rapidly towards zero even when n is small.

Non-Steady State with Unequal River and Estuarine Discharges

So far, the total amount of water in the basin was taken as constant. When ocean outlets are restricted, there may be occasions when the river discharge considerably exceeds the estuarine discharge to the ocean. Equation (2) must then be modified. V_o and b are as before and taken as constant, while k is now defined as

$$k=\frac{\text{volume of estuarine discharge}}{V_o+\text{total river discharge volume}} \tag{3}$$

And salinity at time n is

$$Sal_n=S_n/(V_o+nR) \tag{4}$$

where S_n is given by (2) and (3).

Equation for Probable Lowest Average Salinity

In computing the salinity in the basin after n time units by equation (4), it is necessary to know the magnitudes of S_o, R, k and b where the last two may be interpreted respectively as the magnitudes of the categories tending to decrease or increase the salinity. Unfortunatley, except for S_o and R, they can be evaluated only with difficulty. When, however, the river discharge is large, k, as defined in (3), is small; hence when n is 5 or less and b of the order of magnitude of (1/50) of S_o, the contribution to S_n in (2) comes primarily from the term $S_o(1\text{-}k)^n$. These are the approximate conditions when the average salinity is desired. Hence $S_o(1\text{-}k)^n = S_o$ approximately and equation (4) becomes

$$Sal_n = S_o/(V_o + nR) \doteq (V_o)Sal_o/(V_o + nR) \qquad (5)$$

which is the equation for the probable lowest average salinity. Since the denominator is the final water volume, (5) may be written as

$$Sal_n = Sal_o(\text{original volume})/\text{final volume} \qquad (5a)$$

Probable Lowest Average Salinity in Indian River Lagoon

The approximations employed in arriving at (5) are in general accord with the late summer and early fall conditions in the Indian River when the proposed diversions would be of greatest significance. Hence equation (5) will be used to estimate the probable lowest average salinity during the period when nR values are available. The calender month will be taken as the time unit and hence nR represents the total water diversion into the lagoon for the months concerned. Estimates of nR are given by the U. S. Corps of Engineers; for the period of 1943-1954 when these estimates are available, 1953 had the highest and 1947 had the second highest value of diversion. These are tabulated in columns 3 and 4 of Table 1, while V_o as computed from U.S.C. & G.S. charts number 1245, 6 and 7 are given in column 2 of the same table. The areas referred to in column 1 are shown in Figure 1.

For the two years of 1947 and 1953, nR's are twice as large as the V_o's such that if the proposed water diversions were actually accumulated in the basin through the 3 month period, the depth of water would probably have doubled its initial value. What would have occurred would be that as the diversion water in-

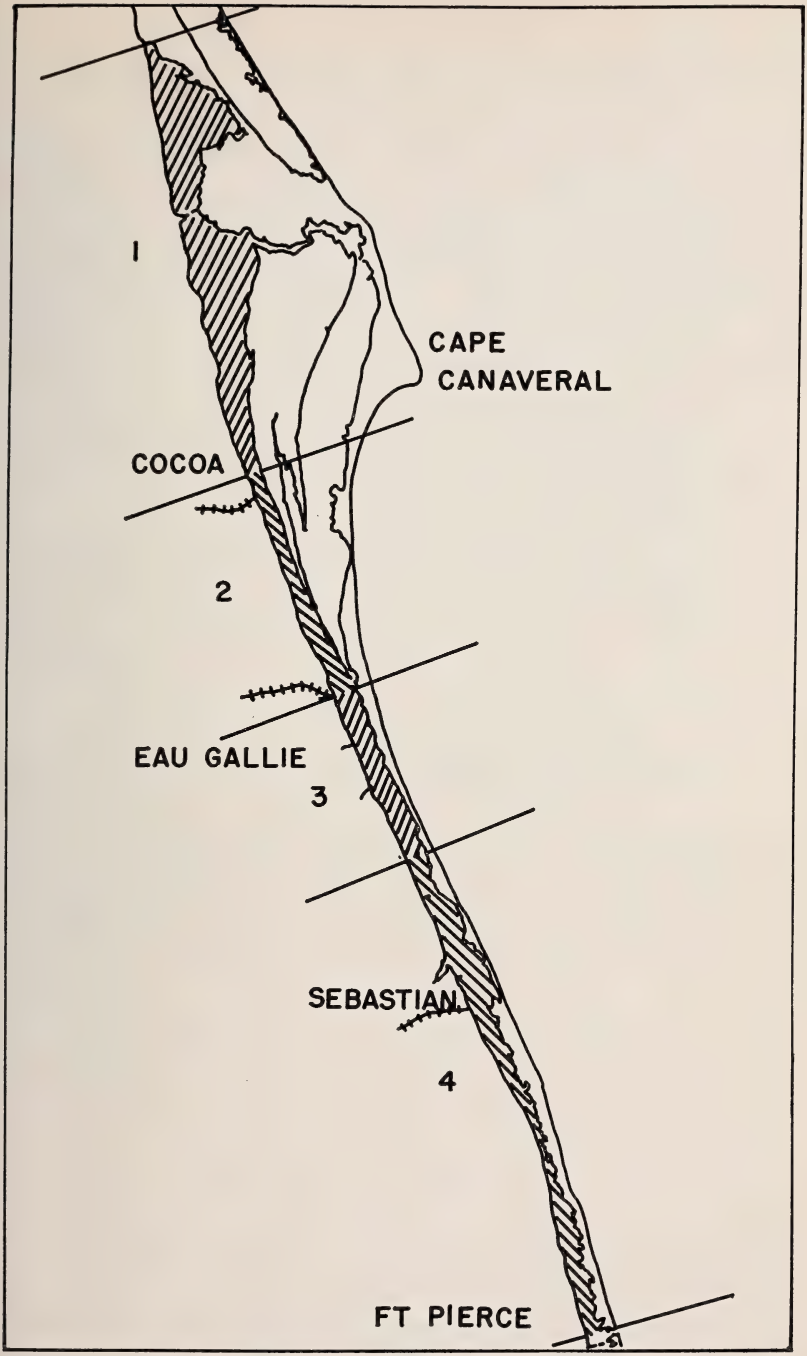

Figure 1. Indian River north of Ft. Pierce and the 4 areas (hatched). The proposed canals are in the vicinities of Cocoa, Eau Gallie and Sebastian.

creases, the estuarine discharge would also increase; thus reducing the fresh water storage but at the same time reducing the initial salt supply in the basin. The final lowest average salinity, therefore, is dependent on the salt content at the time when fresh water storage is at a maximum. Unfortunately, no pertinent data are available for this evaluation. The next possible approach is derived from the realization that salinity effects of increased estuarine discharge tends to be self cancelling. When fresh water storage is reduced by estuarine discharge, thus increasing the salinity, the salt content is also reduced by the same mechanism, thus decreasing the salinity. If then S_0 were the initial salinity directly before the period of significant diversion for the year, the desired salinity may be obtained from equation (5).

No S_0 values are available for 1947, but fortunately there were salinity observations in May, 1953 by the Florida Geological Survey. These are tabulated in column 5 of Table 1. When the total accumulated diversion is assumed to be uniformly distributed over the entire Indian River basin north of Ft. Pierce Inlet, the probable lowest average salinity, Sal_3, is

$$Sal_3 = \frac{20(1070)+20(450)+23(420)+30(380)}{2320+5414} \doteq 7°/oo \qquad (6)$$

It is necessary to recall that complete horizontal and vertical mixing is assumed. Actually, there would be variation of salinity in all directions. Even though horizontal uniformity is favored by the spreading of fresh water diversion, there is continuous

TABLE 1

Magnitudes of V_o and nR (in units of 10^7 ft^3) and Sal_o

Portion of Indian R. corresponding to areas no.	V_o	nR 1947	nR 1953	Sal_o
1	1070	——	——	20 °/oo
2	450	1674	2057	20
3	420	902	1662	23
4	380	1529	1695	30
Total	2320	4105	5414	

salt diffusion into the basin through the two inlets. Hence salinity near the inlets will continue to be high. This pattern is indicated by column 5, Table 1, which shows increasing average salinity southward where the inlets are located. The bottom water will be salter because of vertical stability, but increasing wind stirring in October will reduce this difference and may, on occasion, obliterate it.

Discussion and Conclusion

Mr. Durbin Tabb of the Marine Laboratory has made a special collection of salinity samples from this areas during June 19-23, 1956. The salinity of these samples was determined by a chainomatic pycnometer, Rochford (1954), and the results, along with pertinent information, are tabulated in Table 2. The horizontal pattern revealed by these recent data agrees with that of past salinity, although recent prolonged drought has brought about salinity as high as 41 °/oo in the northern extreme of the Indian River basin.

The basin appears to have a distinct seasonal salinity pattern. Average salinity is highest during the spring months when all excess diversion water has been drained from the basin and the evaporative process has brought about its maximum effect. As the rain season arrives, increasing river discharges and water diversions accompanied by decreasing evaporation combine to effect a minimal average salinity in October. The probable lowest average salinity for each year is thus dependent on both the average salinity before the rain season and the total accumulated water diversion following it.

The assumption of complete mixing is artifical but not without some basis of support for the fall months. The basin is nontidal and hence tidal energy is not available for mixing. At the same time, the strength of the high salinity source is thereby reduced, thus lessening the salinity contrast in the lagoon, especially during periods of large diversion. Three types of mixing energy are available in the fall months; these are convection overturn, wind stirring and the turbulent energy derived from the mean motion of the water diversion. How effective these are in attaining complete mixing must await future study. Perhaps the following (speculative) salinity values for the Indian River north of Ft. Pierce for October, 1953 may not have been too far off: near

TABLE 2

LOCALITY	SALINITY °/oo	TIDE	DATE	TIME
North Bridge, Fort Pierce				
West bank	36.3	out	6/19/'56	0830-0930
Middle	35.9	"	" " "	" "
East bank	36.1	"	" " "	" "
Northeast bridge (Cook Pt.)	36.9	"	" " "	" "
Wabasso Bridge				
50 yds east of West bank of Indian River	37.0	none	6/20/'56	0830-0930
400 yds. " " " " " " "	36.7	"	" " "	" "
800 yds. " " " " " " "	37.1	"	" " "	" "
1500 yds. " " " " " " "	37.0	"	" " "	" "
1750 yds. " " " " " " "	37.5	"	" " "	" "
Melbourne Bridge				
West bank	34.3	"	" " "	1000-1030
200 yds. west of ship channel on bridge	35.0	"	" " "	" "
Ship channel	35.4	"	" " "	" "
East bank	35.1	"	" " "	" "
Banana River, McClintock Pt. on causeway				
10 yds. east of " " " "	32.7	"	" " "	1330-1400
1350 yds. " " " " " "	32.3	"	" " "	" "
3000 yds. " " " " " "	31.3	"	" " "	" "
5000 yds. " " " " " "	33.3	"	" " "	" "
Bridge across Indian River at Cocoa				
200 yds. east of West bank of Indian River	31.2	"	" " "	1415-1440
800 yds. " " " " " " "	31.2	"	" " "	" "
1700 yds. " " " " " " "	30.6	"	" " "	" "
Crane Creek, 550 yds. upstream from mouth	24.6	?	6/23/'56	0900
Bridge across Turkey Creek	16.5	?	" " "	0930
Ship Channel off Turkey Creek mouth	19.1	?	" " "	1000
Ship Channel, 2 miles north of Sebastion Creek	35.9	?	" " "	1045

LOCALITY	SALINITY °/oo	TIDE	DATE	TIME
Intercoastal waterway, north of Cocoa, Indian R.				
Marker 3, mounth of barge canal, Merrit Is.	31.3	none	6/21/'56	0915
4 miles north of Marker 3	31.5	"	" " "	0930
8 miles north of Marker 3	33.7	"	" " "	0945
Marker 43	34.9	"	" " "	1000
Half way between Markers 43 and 32	35.3	"	" " "	1015
Marker 32	37.3	"	" " "	1030
Marker 19	39.1	"	" " "	1045
Marker 3, Mosquito Lagoon	41.3	"	" " "	1100
4 miles northwest of Marker 19	41.0	"	" " "	1115
2 miles west of Marker 19	40.4	"	" " "	1130
Bridge across Indian River off Eau Gallie				
500 yds. from west bank of Indian River	34.0	"	6/23/'56	0730-0815
850 yds. " " " " " "	34.7	"	" " "	" "
1100 yds. " " " " " "	34.6	"	" " "	" "
1300 yds. " " " " " "	34.8	"	" " "	" "
1550 yds. " " " " " "	34.6	"	" " "	" "
2000 yds. " " " " " "	34.4	"	" " "	" "
2600 yds. " " " " " "	34.2	"	" " "	" "
Elbow Creek from highway bridge	30.0	?	" " "	0730-0815
Bridge across Indian River off Vero Beach				
West bank	30.2	?	" " "	1000-1030
Middle	33.7	?	" " "	" "
East bank	37.9	?	" " "	" "
St. Lucie River bridge (Britt Pt.)				
South bank	23.0	out	" " "	1330-1400
Middle	22.4	"	" " "	" "
North bank	22.4	"	" " "	" "
Bridge on A1A, 8/10 mile west of Jupiter Inlet				
South bank	36.0	"	" " "	1430-1500
Middle	36.4	"	" " "	" "
North bank	35.0	"	" " "	" "

mouths of diversion, zero salinity; near inlets, about 15 °/oo; and elsewhere, approximately 7 °/oo.

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A NEW SPECIES OF GOMPHUS FROM ALABAMA (ODONATA)

Minter J. Westfall, Jr.
University of Florida

In *A Manual of the Dragonflies of North America* (1955) the distribution of *Gomphus fraternus* Say includes the area from Maine west to Minnesota and as far south as Virginia, with the three Canadian provinces of Quebec, Ontario, and Manitoba representing the northern boundary. The species is also reported from the southern states of Texas, Arkansas, Mississippi, Alabama and Florida. Specimens from Kentucky have been sent to me by Carl Cook, and they are undoubtedly of this species. In the light of recent findings it becomes necessary to examine critically all records for *fraternus* from south of Kentucky.

The record for Florida was based upon one female seen in the Cornell University collection. The specimen was reported (Westfall, 1953) with some reservation as an addition to the state list. It was taken at River Junction, Gadsden County, on April 9, 1927, and was determined as *fraternus* by J. G. Needham. Since the specimen was subsequently lost and since the closely related *G. hybridus* Williamson was taken by me in this same area, it was included mainly on the basis of existing records for *fraternus* from Alabama, Arkansas, and Mississippi. Further study shows that these two species have been confused several times and it is almost certain that this female was really *hybridus*. I am therefore removing *fraternus* from the Florida list until there is better evidence for including it.

Gomphus fraternus had earlier (Westfall, 1952) been added to the list known from Mississippi. This was based upon three specimens collected by Mrs. Alice L. Dietrich and deposited in the Cornell University collection. Two were from George County, a female from Lucedale, May 20, 1931, and a male from North, April 13, 1931. The third, a male, was from the Leaf River at New Augusta in Perry County, April 30, 1931. These specimens were sent to E. B. Williamson for identification. He labeled them all as "*Gomphus* sp. A", and in addition on the envelope of the female had written the following: "near sp. I identified from Texas as *consanguis* but apparently not identical. E. B. W. 1/16/32".

Subsequently, Dr. Needham identified them as *fraternus*, and this was the name under which they were reported. After collecting numbers of *G. hybridus* in Florida and comparing them with the Mississippi specimens and with a paratype, I am convinced that the Mississippi specimens are *hybridus*. Mr. Williamson described this species in 1902 from specimens taken in Tennessee, many of which were teneral, and until recently it was recognized only from the type series. He did not publish an illustration with his description, and apparently failed to recall this species when identifying the Mississippi specimens. We must now delete *fraternus* from the Mississippi list and add *hybridus*.

The Arkansas record was based upon the male and female reported by Calvert (1901). The male was from Jemmy's Creek, May 17, 1897 and the female from White River, June 10, 1897. Through the kindness of Dr. Calvert these specimens were borrowed from the Philadelphia Academy of Natural Sciences. They were badly broken upon receipt, but could be readily identified as *hybridus*, not *fraternus*. We must delete *fraternus* from the Arkansas list until authentic specimens of this species are found, adding *hybridus* in its place.

Texas was included in the distribution of *fraternus* solely on the basis of the inclusion of that state in the range as given by Williamson (1900). I am unable to learn upon what specimen his record was based. Muttkowski (1910) did not include Texas in his distribution for this species. Edward J. Kormondy has written me that there are no specimens of *fraternus* from southern states in the Williamson Collection at Ann Arbor. The Texas record is apparently in error and perhaps was based upon a specimen of *hybridus*. George Beatty has loaned me for study a male specimen of *hybridus* collected May 7, 1952 at Commerce, Hunt County, Texas, by Alice Ferguson et. al. It agrees well with the paratype and my specimens from Florida. With Mr. Beatty's permission I am reporting this as the first known record of the species from Texas. George Bick during many years of collecting has not taken *fraternus* or *hybridus* in Louisiana.

This leaves the Alabama record to discuss. We included this state on the basis of a list of species collected in Alabama by Septima Smith and Robert H. Hodges. This list was photostated and distributed to colleagues, and bears the date January 1, 1939. I have examined the specimens upon which their record for *frater-*

nus was based, and have determined that they are neither *fraternus* nor any other described species. Mrs. Leonora K. Gloyd in 1939 had noted on the reverse of some of the labels, "near but not *fraternus*". Drs. Smith and Hodges have turned the specimens over to me for description, and Mrs. Gloyd has graciously declined any right of prior discovery.

This species is named for Dr. Septima Smith in recognition of the contribution she has made to our knowledge of the Odonata of Alabama.

Gomphus septima n. sp.

Description of Holotype Male.—General color dark brown to blackish, with pale areas greenish unless otherwise stated.

Head.—Labium pale, the tips of median and lateral lobes slightly suffused with chestnut brown. Tips of maxillae brown to black. Face pale, with pits at ends of suture between labrum and anteclypeus dark brown. Slight darkening along sutures between labrum and anteclypeus and between frons and postclypeus. Top of frons pale, a narrow brown line at its base where it joins the brown vertex. Transverse postocellar ridge with only a few hairs, its outer corners pale. Occiput pale, its crest slightly convex, almost straight in middle, and clothed with brown pubescence. *Pronotum* with anterior lobe yellow in middle, brown laterally. Median lobe pale with brown markings dorsally, and dark brown laterally above the prothoracic coxae and around the prothoracic spiracle. *Synthorax* with middorsal carina and collar pale. Middorsal brown stripe widened anteriorly to become slightly wider than the pale area bordering it on each side. Antehumeral and humeral brown stripes of about equal width, the antehumeral not attaining the crest above, but fused in its upper part with the humeral. The two are also joined slightly at their lower ends. Narrow brown stripe just anterior to lower end of first lateral suture extends upward to level of spiracle which is ringed with black. Second lateral suture suffused with light brown near its upper end. Legs brown to black beyond their pale basal segments. Tibiae unmarked with yellow. Medial surface of prothoracic femora pale. Wings with costa yellow, venation brown to black, stigma brown. No useful specific characters noted in venation. *Abdomen* mostly dark brown, becoming almost black on middle segments. Dorsal pale band extends full length of segments 1-6, becoming pointed at apices of 4-6, and ending

about middle of 7. Segments 8-10 unmarked dorsally. Sides of 1 and 2, and about anterior half of 3 broadly pale upward to level of dorsal part of auricle. Segment 1 with a dense patch of long dark hair just above level of auricle, also with a shining black prominence on posterior margin of segment at lower edge of hairy patch. Upper surface of auricle on segment 2 in part brownish, with the posterior edge bearing about two dozen black prickles. Segments 4-9 with basal pale spots on sides, increasing from less than a fifth the length of segment 4 to half length of 8. Almost entire expanded ventral border of 9 is yellow and the yellow extends dorsally for a distance equal to about half the length of segment. Appendages brown, inferior becoming black in distal half. Superiors about twice length of segment 10, and only slightly longer than inferior. In lateral view each superior bears on its lateral surface a ventrally directed, rounded prominence which is not visible in dorsal view. From this prominence the ventral margin runs upward in a slight curve, then almost straight for a distance equal to about a third the distance from rounded prominence to tip of appendage. It then bends sharply dorsally to the acute apex. The inferior is upturned at its apex. In dorsal view the branches of the inferior project laterally beyond the tips of the superiors for a distance about equal to the width of the tips of the branches. The posterior edge of the inferior forms a straight line in the middle, but the connections with the arching lateral branches are visible from this dorsal view.

Posterior hamules strongly rotated medially so that the tips and "shoulders" are hardly visible in lateral view. Penis with the terminal segment shorter than the third segment. The "tails" of the terminal segment very short and upturned.

Description of Allotype Female.—Coloration similar to male holotype. Pale markings of abdomen more extensive. Dorsal stripe almost full length on segment 7 and a small basal spot on 8 about one-eighth the length of segment. Lateral pale areas almost full length on middle segments. Occiput strongly notched in middle, convex each side of the notch. Vertex with a small brown spine arising a short distance away from the transverse postocellar ridge, so as to lie between each lateral ocellus and the eye (i.e., on the shortest line between these two parts). Abdominal appendages almost twice as long as segment 10. Sub-

genital plate (vulvar lamina) almost half as long as segment 9, the two branches contiguous basally and divergent in apical third.

Variations.—In one male, segment 3 is pale laterally in about the anterior three-fourths of its length, in another pale in almost its entire length. In one male there is a minute dorsal spot at base of 8; in another this spot is about one-seventh the length of segment 8. In two males the dorsal pale area on 7 covers a little more than one-half of length of segment. The rounded protuberance about midlength of the superior appendage may be quite sharp in some specimens. In one male the branches of the inferior appendage as seen in dorsal view project laterally beyond the tips of the superiors for a distance equal to about one and one-half times the width of the tips of the branches.

In two females the spines of the vertex are considerably smaller than in the allotype, but the position is the same. Two females have a pale basal spot on the dorsum of 8. The pale area on side of 9 may be slightly less extensive than in the allotype. In on female the dorsal pale area covers the basal three-fourths of segment 7.

Measurements.—Male holotype, total length 60 (millimeters), abdomen including appendages 43, hind wing 32, superior appendages 1.9. Allotype female, total length 57, abdomen 41, hind wing 35. Paratype males, total length 59-62, abdomen 43-46, hind wing 32-34. Paratype females, total length 53-57, abdomen 39-42, hind wing 34-36.

Holotype.—Male, collected on Warrior River above Blue Creek, Tuscaloosa County, Alabama, May 23, 1940 by Robert S. Hodges. Deposited in University of Florida Collections.

Allotype.—Female, collected on Warrior River, Lock 16, Tuscaloosa County, Alabama, May 17, 1938 by Robert S. Hodges. Deposited in University of Florida Collections.

Paratypes (5 ♂♂, 4 ♀♀).—All from the Warrior River, Tuscaloosa County, Alabama; 2 ♂♂ (one with abdominal segments 5-10 missing) May 17, 1938; 3 ♂♂ (one in alcohol, with hamules and penis removed) May 23, 1940; 1 ♀ May 30, 1937; 1 ♀ June 2, 1937; 1 ♀ May 28, 1939; 1 ♀ (head missing) May 23, 1940. Another male taken May 23, 1940 is represented only by head, thorax, one leg, wing bases and abdominal segments 1-4. All were collected by R. S. Hodges with the exception of the female taken

May 28, 1939 by "The Dragonets". All specimens were shot and suffered some breakage. The one male so badly broken was not designated as a paratype though it is clearly the same species. All paratypes are at the present time in the University of Florida Collections, but some may be distributed to other collections.

REMARKS.—Of the three species of *Gomphus* considered in this paper, *hybridus* may readily be separated from *fraternus* and *septima* by its browner coloration. The other two are both blackish species. As Calvert pointed out for the Arkansas specimens which he called *fraternus* in 1901, *hybridus* males and females have "the side of the thorax, between the first and second lateral sutures filled solidly with pale brown". This diagnostic character is easily seen. The posterior hamules of *septima* are strongly rotated toward the midline so that, when in normal position, the tips and "shoulders" are hardly if at all visible from a lateral view. In *hybridus* there is no such rotation, and in *fraternus* the degree of rotation is only slight. The male of *fraternus* has the posterior edge of the inferior appendage when seen in dorsal view forming a long straight line, the connections with the lateral branches hidden below the superiors. In *septima* the straight line is not so long and the arching sides of the lateral branches give the impression of a concave posterior edge, straight only in the middle. In *hybridus* the straight portion of the posterior edge is still shorter, and the edge appears more concave. In the same view the branches of the inferior are seen to project laterally far beyond the tips of the superiors in *fraternus,* scarcely at all in *hybridus* and *septima* (see fig. 1 in this paper, also figs. 109 and 110 in the *Manual of Dragonflies of North America*). The dorsal view of *fraternus* on page 91 of the *Handbook of Dragonflies of North America* (1929) was apparently transposed with the dorsal view of *hybridus* on the same page. In lateral view the male superior appendage of *septima* (figs. 2 and 6) is different from that of either *fraternus* or *hybridus* (figured in the *Manual*).

The occiput of the female is notched in the middle and convex each side in *septima,* emarginate or toothed in the middle in *fraternus,* and smoothly convex throughout in *hybridus.* The tips of the subgenital plate of *fraternus* are in general more divergent than in *hybridus* and *septima,* but the three species are very much alike in this respect as shown by the figures. In *septima* the spines of the vertex are removed a short distance from the transverse

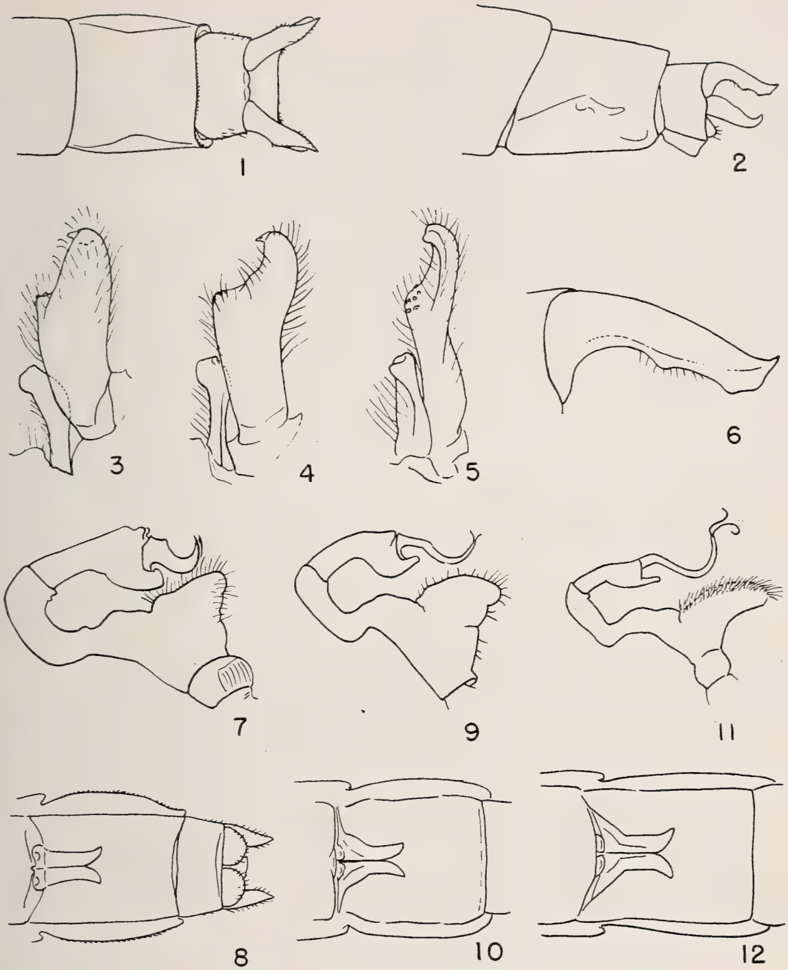

PLATE 1[1]

Figs. 1-8, *Gomphus septima* n. sp. Figs. 9-10, *G. hybridus.*
Figs. 11-12, *G. fraternus.*

Fig. 1, Dorsal view of abdominal segments 9, 10, and appendages of male. Fig. 2, Lateral view of same. Fig. 3, Hamules of second abdominal segment of male almost as they appear in lateral view of insect. Fig. 4, Same hamules rotated slightly. Fig. 5, Same hamules rotated more. Fig. 6, Lateral view of left superior appendage of male. Figs. 7, 9, and 11, Penes of males. Fig. 8, Ventral view of abdominal segments 9, 10, and appendages of female. Figs. 10 and 12, Ventral views of abdominal segment 9 of females.

[1] I am indebted to Miss Esther Coogle, Staff Artist, Department of Biology, University of Florida, for the drawings in this paper.

postocellar ridge, lying on the shortest line between the lateral ocellus and the compound eye. In *hybridus* and *fraternus* the spines are much smaller and are at the ends of the transverse ridge. In this character *septima* is more like *crassus* but is very different in most other respects.

The penis of *septima* differs from that of *fraternus* or *hybridus*, especially in the shape and length of the terminal segment. In *septima* the terminal segment is definitely shorter than the third segment, in the other two species longer. The peduncle of *fraternus* is slender, recurved, and much more hairy than that of *septima* or *hybridus*.

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SOME VISIBILITY PROBLEMS IN LARGE AQUARIA, I. PLANKTON PROBLEMS AT MARINELAND

James B. Lackey
University of Florida

At Marineland, Florida, an oceanarium as an attraction for sightseers has been operating for several years. Essentially it consists of two large tanks, a rectangular tank about 100 feet long by 40 feet wide and 18 feet deep and a circular tank 75 feet in diameter and 12 feet deep. These tanks are open to the sky and have numerous windows in their sides. The water supply is fresh ocean water which filters through sand into a storage gallery from which it is eventually pumped to the thanks. It is treated with a copper sulfate—citric acid compound (Cuprose), toxic to microscopic plants and animals but at the concentration used, not to fish, turtles, porpoises and the various other marine animals which consitute the attraction for sightseers. Visibility in the tanks is high if the water is free from suspended particles, but any particle from colloidal to macroscopic size, interferes with the transmission of light, and as such particles become more and more numerous, it becomes increasingly difficult to see fish or other animals clearly at distances of a few feet from a window, much less 75 feet away on the opposite side of the tank.

Any aquarium or oceanarium if attractive to a visiting public, must fulfill certain qualifications. Among these are: Vigorous, and for the most part, active denizens. Clear water, free from roil, debris and suspended matter. No growth of algae on the windows or walls.

These conditions, especially the second, may be difficult to achieve for a number of reasons. The filtration of the incoming water must be thorough, to remove nonliving suspended matter and to remove as many living organisms as possible. There must be a wastage of some water, so that a complete change of water occurs periodically. Some marine bacteria and some marine plankton forms in bloom proportions have been proved to be toxic to fish (Lackey and Hynes, 1955 and Bein, 1954) while other microorganisms, especially fungi, are infective and then toxic as parasites. Some bacteria and plankters have rapid reproductive rates in the presence of considerable organic matter, and others in the

presence of high nitrates, high phosphates and perhaps other nutrient or stimulative salts or ions. Since aquaria usually have a higher population than a similar volume of ocean water, and since most of the food is dead raw fish, there is an excellent chance that an abundant supply of solid organic material will be present, while fish excreta and feces will supply the remaining food. In short, bacteria and algae should thrive.

A year's study of nonbacterial microscopic life in the tanks at Marineland has shown that these conditions are indeed to be expected, but also that they can be largely prevented. This paper deals with nonbacterial plankton. An accompanying paper covers a somewhat similar but more detailed study of the bacteria, the studies being made simultaneously.

Methods

Once in four weeks, or occasionally more often, a set of samples from the ocean near the intake, the gallery water after filtration, and water from both the circular and rectangular tanks, was examined. Usually the samples were centrifuged within a few minutes after being taken, and the organisms of the catch were identified and counted alive. In some cases, the samples were preserved by adding 5% formalin, settled in the dark, and were examined after several weeks. Counting was done by a drop method (Anonymous, 1955) at magnifications of 100 or 440 diameters.

After about six months the number of nonliving bits of debris were also counted since they far outnumbered the living plankters in the tanks. Those under 40 microns were put in one category, those over 40 microns in another.

Results

Eleven groups of plankters were counted. These were:

Myxophyceae	Bacillarieae
Chlorophyceae	Rhizopoda
Euglenophyceae	Zoomastigophora
Chrysophyceae	Ciliata
Cryptophyceae	Miscellaneous microscopic
Dinoflagellata	animals - rotifers, nematodes, etc.

Table 1 is a list of all organisms identified to species or genus in the course of this investigation. Since the samples were small, 200 to 250 mls., and since they were taken once a month for thirteen months, it seems safe to assume the list represents the most usual algae and protozoa present during the work. The list is not especially unusual; it comprises largely species common to the Atlantic and the Gulf of Mexico inshore waters (Lackey and Hynes, 1955). Some species common to other localities were not found (*Gymnodinium brevis,* various tintinnids), and the number of Chrysophyceae was surprisingly small. But the list is quite representative.

TABLE 1

Organisms Identified In
All Marineland Samples

Myxophyceae	
Anabaena sp.	*Oscillatoria* spp.
Gomphosphaeria aponina	Unid. Blue Green Algae
Nodularia sp.	
Chlorophyceae	
Carteria sp.	Green algal cells
Chlamydomonas spp.	*Pyramidomonas* spp.
Euglenophyceae	
Anisonema ovale	*Eutreptia viridis*
Astasia sp.	*Petalomonas carinata*
Chrysophyceae	
Chrysochromulina sp.	*Syracosphaera carteriae*
Chrysomonadida sp.	*Coccolithophora* spp.
Cryptophyceae	
Chloromonadida sp.	*Rhodomonas lacustris*
Chroomonas sp.	*Thaumatomastix setifera*
Cryptomonas sp.	
Dinophyceae	
Amphidinium sp.	*Peridiniopsis* sp.
Ceratium furca	*Peridinium cerasus*
Ceratium tripos	*Peridinium depressum*
Cochlodinium sp.	*Peridinium divergens*
Dinophysis tripos	*Peridinium punctulatum*
Diplopsalis lenticula	*Peridinium roseum*
Exuviaella marina	*Peridinium trochoideum*
Gonyaulax triacantha	*Peridinium* sp.
Gymnodinium sm., colorless	*Podolampas palmipes*
Gymnodinium alba	*Polykrikos* sp.
Gymnodinium variable	*Prorocentrum gracile*
Gyrodinium lachryma	*Prorocentrum micans*
Gyrodinium sp.	*Prorocentrum triangulatum*

Bacillarieae

Achnanthes longipes
Actinoptychus splendens
Amphiprora gigantea
Amphora ovalis
Asterionella japonica
Biddulphia spp.
Campylosira cymbelliformis
Cerataulina bergonii
Chaetoceras spp.
Cocconeis placentula
Corethron hystrix
Coscinodiscus granii
Coscinodiscus spp.
Diploneis sp.
Ditylum brightwelli
Fragilaria construens
Fragilaria sp.
Grammatophora marina
Guinardia flaccida
Gyrosigma spp.
Hemiaulus membranaceus
Hemiaulus sinensis
Leptocylinrus danicus
Licmophora abbreviata
Lithodesmium sp.
Melosira moniliformis
Melosira sulcata
Navicula spp.
Nitzschia closterium
Nitzschia longissima
Nitzschia seriata
Pleurosigma sp.
Pleurosigma nicobarium
Rhizosolenia alata
Rhizosolenia fragilissima
Rhizosolenia robusta
Rhizosolenia setigera
Rhizosolenia stolterforthi
Rhizosolenia styliformis
Skeletonema costatum
Stephanopyxis turris
Streptotheca thamesis
Synedra ulna
Synedra sp.
Thalassionema nitschoides
Thalassiosira spp.
Thalassiothrix longissima
Triceratium sp.
Tropidoneis sp.
Unid. diatoms

Rhizopoda

Amoeba limax
Amoeba radiosa
Amoebeae spp.
Gromia sp.
Heliozoa spp.
Radioloaria spp.

Zoomastigophora

Bodo sp.
Monas sp.
Monosiga ovata
Oicomonas sp.
Phyllomitus amylophagus
Unid. colorless flagellata

Ciliata

Amphorellopsis acuta
Aspidisca costata
Chilodonella sp.
Codonella sp.
Cyclidium sp.
Cyclotrichium meuneri
Dysteria sp.
Euplotes sp.
Holosticha sp.
Laboea sp.
Lohmaniella sp.
Lembus infusionem
Mesodinium pulex
Nassula sp.
Pleuronema chrysalis
Poroecus sp.
Prorodon sp.
Rhabdonella valdestriata
Steenstrupiella robusta
Stenosemella nivalis
Strobilidium sp.
Strombidium spp.
Tiarina fusus
Tintinnidium primitivum
Tintinnopsis minutus
Tintinnopsis parvula
Tintinnopsis platensis
Tintinnus pectinis
Uronema marina
Vorticella sp.
Unid. ciliata
Suctoria sp.

Table 2 shows the numbers of species and numbers of individuals in each species group, for each of the four locations, on each sampling date. As expected, the numbers in the ocean far outnumbered those in the gallery or tanks. On two occasions, the ocean contained enough organisms to constitute minor blooms—on both occasions the small bloom was due to diatoms.

TABLE 2

Total species and total individuals per sample at Mairneland
Nos. per ml. of water

Date	Gallery		Rect. Tank		Circular Tank		Ocean	
	No. sp.	No. Individuals	No. sp.	No. Individuals	No. sp.	No. Individuals	No. sp.	No. Individuals
12-26-53	5	64	7	78	4	13	29	452
1-20-54	6	11	8	155	13	31	15	83
2-16-54	3	28	5	116	6	158	35	320
3-24-54	5	6	11	14	9	12	39	781
4-23-54	4	58	8	153	3	10	24	149
5-25-54	5	40	15	136	11	27	24	288
6- 1-54	2	22	8	104	4	56	36	500+
7-27-54	2	4	6	120	8	88	21	193
8-19-54	26	58	15	386	23	52	38	261
9-10-54	4	10	5	35	7	35	31	32
10-22-54	3	5	7	58	2	42	37	72
11-15-54	2	2	3	9	3	11	20	20
12-16-54	5	19	9	261	6	49	24	41

Table 2 also shows the effectiveness of the sand filter in removing the organisms from the incoming ocean water; and of the copper citrate treatment as a mechanism for keeping the organism count low. Thus on November 15, 1954, there were only two organisms (Navicula, Cocconeis) per ml. in the gallery water, 1/10 the number per ml. of ocean water. The importance of this removal and prevention of regrowth cannot be overestimated, but it is also hard to visualize unless one has seen the denseness of plankton blooms (up to 30,000,000 cells per ml.) where ocean water is deliberately fertilized to produce them, as in the experimental ponds at Marineland or the food growing tank in the U. S. Fish and Wildlife Laboratory at Milford, Connecticut.

It may be noted from Table 2 that on two occasions the circular tank contained more plankters per ml. than did the ocean, and

the same was true on five occasions for the rectangular tank. The explanation is that the ocean water at Marineland has a low plankton population—there is a long stretch of sandy shore with no particular drainage from the land to fertilize the inshore waters. In addition, the bulk of the tank organisms consists of small naviculoid diatoms and small green algal zoospores. These represent two species resistant to chemical treatment; both grow on the walls from which they must be periodically scrubbed, and on any submerged objects such as the carapace of a turtle. They reproduce prolifically and are a source of considerable trouble and cost.

Besides these two, there is only one other group which occurs in any significant numbers in the tanks. The ciliates sometimes are as abundant in the tanks as in ocean samples taken at the same time. Thus on six dates there were equal or greater numbers in the rectangular tank, and on four dates in the circular tanks. These ciliates do not consitute a problem—their numbers are never sufficiently large. In addition, they feed on bacteria, and would be classed as beneficial. The genera in the tanks are those generally most widespread—Cyclidium, Vorticella, Pleuronema and such—and are very active in their feeding.

Ciliates also indicate a fairly large population of bacteria in the tanks. Thus the average number of ciliates per sample during the work was:

Ocean	5.54
Rectangular Tank	3.61
Circular Tank	2.46
Gallery	.54

This indicates almost as much food in the rectangular tank as in the ocean. And since the filter removes about 90% of the ciliates, there is evidently enough bacterial food in the tanks for their rapid growth. In addition, the copper citrate apparently is not too toxic to ciliates.

Fragments and Debris

After the studies had been under way for some time, it was realized that particles of debris outnumbered the plankters in the tanks. Since many of these exceed 50 microns in size, counts of

the number per ml. were made thereafter. The larger particles were frequently recognizable as pieces of flesh (of the fish used as food), while the smaller were often masses of fecal matter. The latter often seemed to be a nidus for groups of naviculoid diatoms.

Many of the particles were simply amorphous masses of unknown composition. An average of the numbers per ml. for six sampling dates (large size) and three sampling dates (small size) shows their relative abundance as compared to the plankters:

	Gallery	Rect. Tank	Circ. Tank
Over 40μ	41	111	76
Under 40μ	58	93	133

On the basis of this rather sketchy data, it would seem that a substantial amount of the light extinction might be due to particles, and that serious consideration should be given either to recirculation of large amounts of the tank water through a fine filter; or that a more rapid intake of filtered sea water be installed. The initial number of such flocs or particles is rather large in the gallery water, but seems to be doubled or tripled in the tanks. It is inferred that the above numbers are rather constant—i.e., about the same routine feeding procedure produces about the same amount of particles. Since they apparently do not interfere too much with visibility, perhaps no change is needed, but at least one caution should be stated: if the chemical controls for bacterial and plankton growth break down for even a short time, these particles offer a substrate for very heavy growth, and could indirectly cause a drop in visibility in a matter of a few hours.

It is evident that the bacteriological studies on the tanks go hand-in-hand with studies of this nature. This study and that by E. W. Lackey (1956) are presented as a contribution to the knowledge of management of large quanities of aquarium water. At the same time they take into account the ecology of the bacteria and plankters present in ocean water used for aquaria.

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SOME VISIBILITY PROBLEMS IN LARGE AQUARIA, II. A BACTERIOLOGICAL STUDY OF THE SEA WATER USED IN MARINELAND

Elsie Wattie Lackey
University of Florida

The appeal of oceanariums to the general public is greatly enhanced by being able to look into the tanks at fish eye level, and see the inhabitants face to face, or to side, at a few inches or a distance of many feet. Consequently anything interfering with such vision should be kept closely under control. The tanks at Marineland Oceanarium, Marineland, Florida, occasionally become turbid to varying degrees, often within a few hours.

Due to such occasional turbidity of the water in the circular and rectangular tanks it was decided to make monthly bacterial examinations over a period of one year. Samples were to be collected from the ocean, gallery, circular tank and rectangular tank. Standard bacteriological technique was followed throughout, using sea water agar (Zobell) and sea water diluting water (Zobell). All sample plates were incubated 48 hours at room temperature before counting the bacterial colonies.

A complete set of water samples from the ocean, gallery, circular and rectangular tanks was collected prior to he first daily feeding of the fish, porpoises and turtles at 10:00 a.m. A sample of gallery water and from the two tanks was collected at 12:00 noon. The last set of samples, same as at 12:00 noon, was collected just before the last daily feeding at 4:00 p.m. No specific time during the month was selected for making the examination. It was recognized that there were a large number of variables which would tend to influence the bacterial population. These variables include temperature, weather—storms and high seas, the amount of fresh sea water added to the system, unconsumed fish food, fish excreta and the bacterial toxicity of the copper treatment used. The results obtained from the monthly examinations are presented in Table 1.

The results of the examinations are expressed in bacteria per ml—which can be interpreted as the number of bacteria present at the time of examination which will form colonies on the specific media used and at the incubating temperature within a period of 48 hours.

TABLE 1

Bacterial Results of Water Samples Collected from the Ocean, Gallery and Circular and Rectangular Tanks at Marineland

Month	Ocean			Gallery Samples					
				10:00 A.M.		12:00 Noon		4:00 P.M.	
	Bact./ml.	pH	Temp. °C	Bact./ml.	Temp. °C	Bact./ml.	Temp. °C	Bact./ml.	Temp. °C
Dec. '53	2600	8.1		200	21				
Jan. '54	1390	8.1	17	50					
Feb.	920	8.1	16	22	16.5	5	17	2	
March	150	8.1	18	2	19	2	19	1	18.5
April	1120	8.0	27	2	22	1	25	2	22
May	4500	8.1	24.5	170	23	30	23	1460	
June*	3750	8.0	25.5	194	25	21	25	6	24.5
July	1300	8.2	28	6	27	15	27.5	8	
Aug.	2500	8.0	27	2	27	3	26.5	2	26.5
Sept.	5400	8.2	29.5	2	27.5	6	27.5	3	27.5
Oct.	420	8.1	22.5	2	23.5	1	23.5	1	23.5
Nov.	810	8.15	19	1	20	3	20	1	20
Dec.	295	8.15	15	1	15	1	16	1	17
Jan. '55	8			1	18	1	18	1	18

* Average of two examinations made on consecutive days.

TABLE 1

Bacterial Results of Water Samples Collected from the Ocean, Gallery and Circular and Rectangular Tanks at Marineland

Month	Circular Tank						Rectangular Tank					
	10:00 A.M.		12:00 Noon		4:00 P.M.		10:00 A.M.		12:00 Noon		4:00 P.M.	
	Bact./ ml.	Temp. °C	Bact./ ml.	Temp. °C	Bact./ ml.	Temp. °C	Bact./ ml.	Temp. °C	Bact./ ml.	Temp. °C	Bact./ ml.	Temp. °C
Dec. '53	500						4500	20.5				
Jan. '54	1720	18			400	19	6100	18			2800	20.5
Feb.	750	17	1400	17.5	1040	17.5	810	19.5	2070	19.5	2480	19.5
March	870	20	420	19.5	420	19.5	1800	20.5	3300	19.5	2680	21.5
April	820	22	1520	22.5	1260	22.5	1800	22.5	2080	22.5	1580	23
May	740	23	1220	23	940	23.5	1020	23	1260	23.5	1100	24
June*	3700	24	2650	24	1260	25	26200	24	29700	25	15800	25
July	540	27	4200	27	5050		430	27	5400	27	7800	
Aug.	365	26.5	1220	27	4600	27	735	25	4100	27	3200	27
Sept.	1140	28.5	3140	29	7600	28.5	830	28	4800	29	3600	29
Oct.	700	23.5	640	24	310	24	1210	23	1490	24	985	23.5
Nov.	900	20	770	21	630	20	1050	20	3160	20.5	980	21
Dec.	90	16	220	16	170	17	300	19	320	19	290	20
Jan. '55	9	18	40	18	29	21	327	20.5	530	20.5	690	21

* Average of two examinations made on consecutive days.

After the study had progressed several months, it was observed that there was a tendency for the total number of bacteria present in the 12:00 noon and 4:00 p.m. samples from the circular and rectangular tanks to be somewhat higher than the 10:00 a.m. sample. It was decided, therefore, to obtain additional samples to determine if there was a drop in bacterial number during the night. Samples from the two tanks were collected the day before the routine examinations were to be made at 6:00 p.m. and 12:00 midnight, as well as a set at 6:00 a.m. the sampling day. These additional samples were collected by the attendant on duty and were stored in the refrigerator until examined. The results obtained from these samples are presented in Table 2.

TABLE 2

A. Circular Tank

Month	Bacteria Per Milliliter					
	6 p.m.	12 M.	6 a.m.	10 a.m.	12 N.	4 p.m.
April	6500*	12500*	1270*	820	1520	1260
June	5210	6450	1790	3700	2650	1260
August	29400	14800	990	365	1220	4600
September	2290	6000	2910	1140	3140	7600
November	3200	365	240	900	770	630
December	450	2450	70	90	220	170
January	16	20	10	9	40	29

B. Rectangular Tank

Month	Bacteria Per Milliliter					
	6 p.m.	12 M.	6 a.m.	10 a.m.	12 N.	4 p.m.
April	9900*	4000*	1980*	1800	2080	1580
June	25200	33800	17400	26200	29200	15800
August	18900	6000	2700	735	4100	3200
September	2000	2010	3100	830	4800	3600
November	7200	8100	2050	1050	3160	980
December	520	3380	90	300	320	290
January	446	408	370	327	530	690

* Sample not refrigerated

The first set of these samples, April, were not stored in the refrigerator until examined and bacterial counts of the 6:00 p.m., 12:00 midnight, and 6:00 a.m. samples may be in error due to bacterial multiplication.

In general, the results indicate that in the circular tank there were fewer bacteria present in the 6:00 a.m. or 10:00 a.m. samples. There is the same tendency in the rectangular tank but it is not quite so clear cut. This may be due to the fact that in the circular tank only whole fish are fed to the porpoises whereas in the rectangular tank cut fish is fed to the fish and small particles of the flesh float off which if allowed to remain in the tank, will become food for bacteria. With the addition of such particles several times a day, it is apparent they contribute to the number of bacteria present.

It is also quite evident that the water temperature is a factor. Since the tanks are open to the sunshine, the water temperature will naturally show a diurnal rise, and controlling this factor would require cooling the sea water for the summer months. In the summer, the rise in temperature both in the ocean and in the tanks themselves is sufficient to produce substantial rises in bacterial populations.

Throughout the year, water from the tanks passes through filters. A larger amount is recirculated in the winter time when "a closed system" is in operation. Beginning in March, samples were collected from the top and bottom of the filters. The results from these samples are presented in Table 3.

TABLE 3

Filter Samples

Year	Month	Bact. Per ml Filter Top	Bact. Per ml Filter Bottom
1954	March	5300	1610
	April	2400	1420
	May	5500	1120
	June	51800	12300
	July	18500	900
	August	4900	1470
	September	4600	2120
	October	4000	2500
	November	965	595
	December	495	285
1955	January	2750	730

It is apparent that the number of bacteria was reduced by the filters. No data were available as to when the filters were backwashed, how often it was done or the amount recirculated. Dur-

ing the "summer operation" it is understood that since less water returns to the tanks, a greater volume of fresh sea water is constantly added to the system. During "winter operation" a greater amount of water is recirculated and less fresh sea water added because of the lower temperature of the sea water. A few days before the June examination was made the filters were not functioning properly and the visibility dropped to 40 feet. The result of this is shown in the bacteriological results. Particles of cut fish, debris, and plankton are removed by the filters as well as bacteria. It is, therefore, essential that the filters operate efficiently and that they are sufficient in size to handle the load.

Conclusions

The literature on such bacterial examinations is very meagre and any findings would be of value in the control of other similar oceanariums. The data collected over the past year bring out several interesting facts:

1. Bacteria alone do not cause all of the turbidity in the circular and rectangular tanks, but are a contributing factor.

2. The uneaten particles of fish food in the rectangular tank furnish ample food for the bacteria present.

3. It would be interesting and very helpful if accurate checks could be made at all times as to the amount of fresh sea water being added to each tank.

4. If, in addition to passing the recirculated water through the filters, the water was also chlorinated and neutralized before returning it to the tanks, lower bacterial counts could be obtained. Close check on the efficiency of the filters is needed, and if the present set up is not sufficient to handle the load, additional filters would be needed. Coagulation and sedimentation might be helpful in removing the turbidity of the recirculated water.

5. Constant interest and awareness should recognize that the bacteria and other microorganisms present in the tanks will have a tendency to develop an immunity for the copper treatment now in operation. A sudden drop or increase in the amount of copper being used for a short time might

tend to forstall this for a greater period of time. Experimental work on a small scale with various bactericidal compounds might give some profitable results. Such work would result in determining a bactericidal agent to be kept as a standby in case the copper treatment fails to function for any reason, or if such an immunity develops.

6. These studies confirm previously held ideas that quick reductions in visibility are largely due to sudden bacterial growth, and not to particles or plankton passing the filters.

A CHECKLIST OF THE CEPHALOPODS OF FLORIDA[1]

Gilbert L. Voss
University of Miami

Introduction

The cephalopods of Florida have never been reviewed, and little can be found in the literature concerning their systematics or distribution. Unfortunately, the few early reports are either erroneous or the names employed are such as to make present identification difficult or impossible. The first published report seems to be the description of the squid, *Loligo hemiptera,* by Howell in 1868. This squid has since been shown to be synonymous with the thumbstall squid, *Lolliguncula brevis.*

In 1878 Calkins, in his Catalogue of the Marine Shells of Florida, recorded *Argonauta argo, Octopus rugosus* (= *O. vulgaris*), *O. vulgaris, Onychoteuthis bartlingii* (= *O. banksi*) and *Spirula peronii* (= *S. spirula*) from the Florida coasts. His statement that *Octopus rugosus* occurs in the Gulf Stream casts some doubt upon its identity, however, as no member of the genus *Octopus* is pelagic. He may have referred to *Tremoctopus violaceus.* Again, *Octopus vulgaris* may refer to *O. briareus,* unknown at that time.

Simpson, in 1887, lists *Octopus rugosus* and *vulgaris,* a pen possibly from an *Ommastrephes,* and the shells of *Spirula peronii* (= *S. spirula*) from the Florida coasts.

In 1882, Verrill published his review of the cephalopods of the Atlantic coast and mentions records of three squids from Florida waters: *Loligo gahi, Sepioteuthis sepioidea,* and *Lolliguncula brevis.* Unfortunately, *Loligo gahi* is not known to occur in the waters around Florida as it is native to the west coast of South America. Probably this was *Doryteuthis plei,* the arrow squid, but the exact identity of Verrill's specimen remains uncertain.

In 1929-1931 Robson published his monographic review of the octopoda, mentioning various records from Florida, and in 1932 he discussed briefly some octopods and their eggs from the Dry Tortugas and the west coast of Florida, mostly from material collected by T. H. van Hyning.

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[1] Contribution No. 164 from the Marine Laboratory, University of Miami.

In 1937, Adam reported upon the collections made in the West Indies by the Belgian school ship MERCATOR and described a small octopod, *Octopus mercatoris,* collected at the Dry Tortugas. However, Pickford (1945) showed, in her monographic review of the littoral octopods of the Western Atlantic, that this was a small *O. joubini.* She listed three octopods, *O. vulgaris, O. briareus,* and *O. joubini,* as occurring in Florida waters.

Berry (1934) lists about 55 valid species for the coast of the eastern United States and of these 8 are reported from Florida coasts, including a small octopod described by him (1920) as *Polypus scorpio* and now considered to be the young stage of *Scaeurgus unicirrhus.*

Smith (1937) in his East Coast Marine Shells, long a standard work for shell collectors along the Florida coasts, lists 5 species from Florida of which *Argonauta gondola* and *Octopus rugosus* are synonyms for *Argonauta hians* and *Octopus vulgaris.*

Since 1949 the present author has published a series of papers (1949-1954), on the cephalopods of the coasts of Florida, based upon material in the collections of the Marine Laboratory, the United States National Museum and the Museum of Comparative Zoology at Harvard. The collections made by the ATLANTIS off Cuba in 1938-39 (Voss, 1955) added considerably to our knowledge of Floridan cephalopods. Since 1950 the U. S. Fish and Wildlife Service vessel OREGON has been doing exploratory work in the Gulf of Mexico, much of it off the west and northwest coast of Florida, and the results of this work were published recently (Voss, 1956).

In the course of these studies the author has compiled a checklist of the cephalopods of Florida and this now amounts to 39 species. These species are listed in phylogenetic order in the following checklist, together with a note as to their habitat and all of the records available to the author at the present time. In the listing of the records ML is used for records accumulated by the Marine Laboratory of the University of Miami, USNM for records in the United States National Museum, and MCZ for records in the Museum of Comparative Zoology at Harvard.

OREGON refers to collections made by the United States Fish & Wildlife Service vessel OREGON, and TRITON to a small collection of cephalopods made by T. L. and P. L. McGinty aboard the yacht TRITON owned by A. R. Thompson. The name

Pickford refers to the records of octopods given by Pickford (1945).

Keys and figures to most of the species recorded here may be found in Voss (1955 and 1956):

Class CEPHALOPODA

Subclass Coleoidea

Order *Sepioidea*

Family Spirulidae

Genus *Spirula* Lamarck, 1799

S. spirula (Linnaeus, 1758)

Shells as flotsam on both coasts. The living animal is found only in deep water and is unrecorded off Florida.

Family Sepiolidae

Genus *Rossia* Owen, 1828

R. tenera (Verrill, 1880)

In deep water off both coasts. 40-60 fms. off Palm Beach (TRITON); 100 fms. off Miami, 90-125 fms. off Sombrero Light, Dry Tortugas (all ML); upper Gulf (OREGON).

R. equalis Voss, 1950

In deep water off both coasts 65-100 fms. off Sombrero Light (USNM, ML), 100 fms. off Pelican Shoal (ML), upper Gulf (OREGON).

R. antillensis Voss, 1955

In deep water off both coasts. 105 fms. off Jacksonville Beach (ML), off Pensacola (ORGEON).

R. bullisi Voss, 1956

In deep water off north west Florida in 200-262 fathoms. (OREGON).

R. tortugaensis Voss, 1956

Off Dry Tortugas in 283-375 fathoms (USNM).

Order *Teuthoidea*

Suborder MYOPSIDA

Family Pickfordiateuthidae

Genus *Pickfordiateuthis* Voss, 1953

P. pulchella Voss, 1953

A small species living in *Thalassia* beds. Bear Cut, Miami (ML), Crandon Park, Key Biscayne; Old Rhodes Key; Key West (ML, USNM, all collected by Craig Phillips).

Family Loliginidae

Genus *Lolliguncula* Steenstrup, 1881

L. brevis (Blainville, 1823)

This is *Loligo hemiptera* Howell, 1868. It is a coastal shallow water species occasionally venturing into brackish water. Fernandina, Miami, Key Largo (ML); Key West (MCZ, ML); Dry Tortugas (ML); Charlotte Harbor (MCZ); Tampa, Apalachicola Bay, Cape San Blas (all ML).

Genus *Loligo* Lamarck, 1798

L. pealei Lesuer, 1821

Not common in our area. Fernandina, Miami, Key West, 10 fms. off Dry Tortugas (all ML); upper Gulf (OREGON).

Genus *Sepioteuthis* Blainville, 1824

S. sepioidea (Blainville, 1823)

This is a tropical species limited apparently to the lower east coast. Miami, Biscayne Bay, Garden Cove (all ML); Key West (MCZ, ML); Dry Tortugas (Verrill).

Genus *Doryteuthis* Naef, 1912

D. plei (Blainville, 1823)

The arrow squid is a tropical species limited in its northward range to south Georgia. Miami, Florida Keys, Dry Tortugas (all ML).

Family Enoploteuthidae

Genus *Abralia* Gray, 1849

A. veranyi (Rűppell, 1844)

A bathypelagic species. Taken in plankton tow off Key West (ML).

A. redfieldi Voss, 1955

Bathypelagic. Recorded from plankton hauls in the Florida Current off Miami (ML).

Genus *Abraliopsis* Joubin, 1896

A. morissi (Verany, 1837)

Bathypelagic. Recorded from plankton hauls in the Florida Current off Miami (ML).

Genus *Thelidioteuthis* Pfeffer, 1900

T. alessandrini (Verany, 1851)

Bathypelagic. Recorded from plankton hauls off Miami in the Florida Current (ML).

Genus *Pyroteuthis* Hoyle, 1904

P. margaritifera (Rüppell, 1844)

Bathypelagic. Recorded from plankton hauls in the Florida Current off Miami (ML).

Genus *Pterygioteuthis* Fischer, 1896

P. giardi Fischer, 1896

Bathypelagic. Recorded from plankton hauls in the Florida Current off Miami.

Family Octopodoteuthidae

Genus *Octopodoteuthopsis* Pfeffer, 1912

O. megaptera (Verrill, 1885)

Bathypelagic. Recorded from plankton hauls in the Florida Current off Miami (ML).

Family Onychoteuthidae

Genus *Onychia* Lesueur, 1821

O. caribaea Lesueur, 1821

Oceanic. Washed up on the beach at South Lake Worth Inlet (ML); Miami, Sanibel Island (all ML).

Genus *Onychoteuthis* Lichtenstein, 1818

O. banksi (Leach, 1817)

Oceanic. Off Miami, Key West, Dry Tortugas (all ML).

Family Architeuthidae

Genus *Architeuthis* Steenstrup, 1857

A. princeps Verrill, 1875

The giant squid has only been reported once from the Florida coast. A mangled specimen about 18 feet in length was picked up on the surface off Fowey Rock Light (ML).

Family Histioteuthidae

Genus *Calliteuthis* Verrill, 1880

C. reversa Verrill, 1880

Bathypelagic. Fragments of a head and arms attributed to this species have been taken from the stomach of a dolphin, *Coryphaena,* off Miami (ML).

Family Ommastrephidae

Genus *Illex* Steenstrup, 1880

I. illecebrosus (Lesueur, 1821)

Oceanic. Off Jacksonville Beach in 105 fathoms, Dry Tortugas (all ML).

Genus *Ommastrephes* Orbigny, 1839

O. pteropus Steenstrup, 1856

Oceanic. Caught alive off the beach at Palm Beach, Miami, Dry Tortugas (all ML); upper Gulf (OREGON).

Family Cranchiidae

Genus *Cranchia* Leach, 1817

C. scabra Leach, 1817

Planktonic. Melbourne, Hillsboro Inlet, off Miami (all ML); Key West (ML).

Order *Octopoda*

Family Octopodidae

Genus *Tetracheledone* Voss, 1955

T. spinicirrus Voss, 1955

A deep water species. 105 fms. off Jacksonville Beach (ML); upper Gulf (OREGON).

Genus *Octopus* Lamarck, 1798

O. briareus Robson, 1929

Shallow water. Lantana, Miami, Soldier Key, Ragged Keys (all ML); Upper Matecumbe (ML); Teatable Key, Indian Key, Long Key, Sand Key, Key West (all Pickford); Dry Tortugas (Pickford, ML); Marquesas Key (Pickford); Anclote Key off Tarpon Springs (Pickford).

O. burryi Voss, 1950

Moderate to deep water. Off Sombrero Key in 100 fms. (USNM); upper Gulf (OREGON).

O. joubini Robson, 1929

Shallow water. This is *O. mercatoris* Adam, 1937, from Dry Tortugas. This small species commonly lives within small bivalve shells. Biscayne Bay, Soldier Key, Marco Beach, Sanibel Island (ML); Captiva Island, Stock Island, Palmetto Key, Pine Island Sound, Pelican Bay, Tampa, Port St. Joe (all Pickford).

O. hummelincki Adam, 1936

Shallow water. Easily identified by the purple ocellus below the eye. Long Reef, French Reef, Molasses Reef (all ML).

O. macropus Risso, 1826

Shallow to moderate depths. Only reported once from shrimp haul off Key Biscayne (ML).

O. vulgaris Lamarck, 1798

Shallow water. North Lake Worth Inlet (Pickford); South Lake Worth Inlet (ML); Miami Beach (ML); Largo Sound (ML); Teatable Key (ML); Indian Key (ML); Sand Key (Pickford); Dry Tortugas (ML, Pickford); Captiva Island, Egmont Key, Tampa, Anclote Key, Homosassa River, (all Pickford).

Genus *Danoctopus* Joubin, 1933

D. schmidti Joubin, 1933

Recorded from off Dry Tortugas in 283 fms. (USNM).

Genus *Bathypolypus* Grimpe, 1921

B. arcticus (Prosch, 1849)

Deep water. 105 fms. off Jacksonville Beach (ML); off Delray Beach (MCZ).

Genus *Scaeurgus* Troschel, 1857

S. unicirrhus (Orbigny, 1840)

Moderate depths. 40-50 fms. off Palm Beach, 50 fms. off Delray Beach, 85 fms. off Sombrero Light (all TRITON); off Key West in 200 fms. in old beer bottle (ML). This is the adult of *Polypus scorpio* Berry, 1920, from off Miami.

Genus *Pteroctopus* Fischer, 1882

P. tetracirrhus (Delle Chiaje, 1830)

Moderate depths. 40-60 fms. off Palm Beach (TRITON); upper Gulf (OREGON).

Family Tremoctopodidae

Genus *Tremoctopus* Delle Chiaje, 1830

T. violaceus Delle Chiaje, 1830

Pelagic. Boynton Beach, Pompano Beach, Fort Lauderdale, Miami, Cape Florida (all ML).

Family Argonautidae

Genus *Argonauta* Linnaeus, 1758

A. argo Linnaeus, 1758

Shells as flotsam on Atlantic and Gulf beaches. The shells with animals have been recorded from: Palm Beach, Boynton Beach, Delray

Beach, Pompano, Fort Lauderdale, Miami, Bear Cut (all ML). They are commonly eaten by both dolphin and sailfish.

A. *hians* Solander, 1786

Shells rarely found as flotsam. Delray Beach, Pompano Beach as shells (all ML); in dolphin stomachs from off Miami (ML).

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Report on the 21st Annual Meeting
University of Tampa
Tampa, Florida

November 29-30, December 1, 1956

At the Annual Meeting the following officers were elected:

President: C. P. Tebeau, Chemistry Department, University of Miami, Coral Gables, Florida.

President-elect: D. A. Thomas, Physics Department, Rollins College, Winter Park, Florida.

Secretary-Treasurer: R. A. Edwards, Geology Department, University of Florida, Gainesville, Florida.

Council Members: W. H. Leigh, Department of Zoology, University of Miami, Coral Gables, University Branch 46, Florida; Earl D. Smith, Florida Southern College, Lakeland, Florida.

Section Chairmen:

Biological Sciences: Keith L. Hansen, Biology Department, Stetson University, DeLand, Florida.

Physical Sciences: Alfred P. Mills, Department of Chemistry, University of Miami, Coral Gables, Florida.

Medical Sciences: W. F. Dunning, University of Miami, Department of Microbiology, Coral Gables 46, Florida.

Social Sciences: H. T. Grace, Elementary Education Department, Florida Southern College, Lakeland, Florida.

E. Ruffin Jones, reporting for the Long Range Planning Committee, stated that suggestions had been made for certain revisions in the Constitution and By-Laws, and that the Council had appointed a committee to study these changes and present them to the members prior to the next Annual Meeting.

A proposal requesting financial aid from the National Science Foundation to establish a program which would develop a model Junior Academy of Sciences in Florida was presented to the membership. This matter was approved in principle by the members, and the Council was directed to work out the details.

Miss Louise Williams of Lakeland High School, who has been councilor for the Junior Academy, found it necessary to resign this responsible position. President Wallace recognized the valuable contributions Miss Williams has made to the Junior Academy program, and the members of the Academy expressed their appreciation by a unanimous vote of thanks.

The Academy will sponsor again this year the Science Talent Search through a committee whose chairman is R. D. MacCurdy.

Raymond F. Bellamy, Chairman of the Resolutions Committee, presented these resolutions which were adopted by the Academy:

We offer the following resolutions:

That we extend thanks and appreciation to

First—The University of Tampa for their hospitality and for the way in which they have put their facilities at our disposal.

Second—The Local Committee, with especial mention of the Chairman, Professor Clyde T. Reed, who has worked with his typical and oft repeated vigor.

Third—The Program Committee for developing an excellent program, characterized by treatment of practical and contemporary topics, such as, the impact of atomic energy on Florida, cloud seeding, treatment of malfactors, the Salk vaccine, and also by papers on equally scholarly but more general subjects.

Fourth—The officials of the Academy for their good work and for setting standards which we hope the new officers will equal.

Fifth—The group of faithful members who for many years have constituted the backbone of the Academy and who are always present and active.

Sixth—The city of Tampa and its Chamber of Commerce which furnished maps and performed other services.

Seventh—The Press for their friendly and competent treatment of the meeting.

We deplore the fact that so many capable scientists in the state are uninterested or perhaps ignorant of the activities and values of the Academy, and we urge the Section Chairmen, the Program Committee, the Membership Committee, all other officials, and the members at large to redouble their efforts to bring these unfortunate and erring scholars into the fold.

We are pleased with the addition of the Medical Science Section and look forward to the addition of other sections and to the further growth and development of the Academy.

INSTRUCTIONS FOR AUTHORS

Contributions to the JOURNAL may be in any of the fields of Sciences, by any member of the Academy. Contributions from non-members may be accepted by the Editors when the scope of the paper or the nature of the contents warrants acceptance in their opinion. Acceptance of papers will be determined by the amount and character of new information and the form in which it is presented. Articles must not duplicate, in any substantial way, material that is published elsewhere. Articles of excessive length, and those containing tabular material and/or engravings can be published only with the cooperation of the author. Manuscripts are examined by members of the Editorial Board or other competent critics.

MANUSCRIPT FORM.—(1) Typewrite material, using one side of paper only; (2) double space *all* material and leave liberal margins; (3) use 8½ x 11 inch paper of standard weight; (4) do not submit carbon copies; (5) place tables on separate pages; (6) footnotes should be avoided whenever possible; (7) titles should be short; (8) method of citation and bibliographic style must conform to JOURNAL style—see Volume 16, No. 1 and later issues; (9) a factual summary is recommended for longer papers.

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THE QUARTERLY JOURNAL OF THE FLORIDA ACADEMY OF SCIENCES

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THE RAPID MINERALIZATION OF ORGANIC REMAINS IN FLORIDA, AND ITS BEARING ON SUPPOSED PLEISTOCENE RECORDS[1]

Wilfred T. Neill
Silver Springs, Florida

Toward the latter 1800's, there were several finds of heavily mineralized human remains in Florida. At a locality on Sarasota Bay, human bones were found imbedded in a soft ferruginous rock. Further excavations in the general area revealed a skeleton in ferruginous sandstone; the bone substance had been entirely replaced by limonite (Heilprin, 1887; Leidy, 1889). In other parts of the state, human skulls were discovered in masses of breccia. At first, great age was attributed to the various finds, mostly on the basis of the degree of mineralization. However, somatologically the bones were those of American Indians; and in some cases they were associated with artifacts, such as pottery, which elsewhere in the state appeared to be of no great age. Furthermore, the most impressively mineralized skeleton, that from Sarasota Bay, was accompanied by the remains of modern animals only. Dall (1887) reasonably concluded that, in parts of Florida, mineralization must proceed at a very rapid rate, and that one is not justified in assigning an early dating to remains from this state simply because they are completely petrified. Hrdlicka (1907) reached a similar decision after study of the geological and archeological evidence. Recently developed techniques of archeological dating have amply borne out the conclusions of Dall and Hrdlicka, in so far as they relate to petrifaction as a measure of antiquity in Florida. Thus it has become evident, at least to archeologists, that in Florida

[1] A contribution from the *Research Division, Ross Allen Reptile Institute.*

mineralization is not necessarily an indication of Pleistocene or even "early Recent" age (see Goggin, 1952; Rouse, 1951; and Willey, 1949). Unfortunately, this dictum has been overlooked by some zoologists, who continue to assign at least a Pleistocene dating to all fossilized animal remains from this state.

I wish to emphasize that, under conditions frequently met with in Florida, petrifaction is a matter of centuries, not millennia; to report that, under ideal conditions, it is a mere matter of decades; and to discuss certain remains which have been ascribed, perhaps erroneously, to the Pleistocene.

At this point it seems desirable to explain what is mean by "Pleistocene." This epoch is differentiated from the preceding one by glaciations and the establishment of climatic zones, but to draw a line between Pleistocene and Recent is pure arbitration (Hibbard, 1949). The line has been drawn in a variety of ways, and by many authors, but never in really satisfactory fashion (Ray, 1949). Most zoologists, pronouncing various remains from Florida to be of "Pleistocene" rather than of "Recent" age, have given no indication of the way they distinguish these time periods. Although from a geological standpoint the Pleistocene has not ended, it is zoologically useful to separate the last part of post-Pliocene times, characterized by a modern fauna, from the preceding part when elephants, giant bison, etc. also flourished. Flint (1947) and Hibbard (*op. cit.*) have recommended that the term "recent" (with a lower-case "r") be used in an informal and local sense to designate the time period characterized by the modern fauna. Their recommendation is followed herein; "Pleistocene" and "recent" are thus distinguished faunistically. Probably the majority of zoologists have had some such distinction in mind when assigning remains to the Florida Pleistocene without additional comment.

With this preamble we may turn to the subject of mineralization and its bearing on supposed Pleistocene records. Three instances of very rapid mineralization may be cited. At the Reptile Institute a crocodile was kept in an enclosure built along a natural stream, a tributary of Silver Springs run in Marion County, Florida. On one occasion a quantity of redfish heads were purchased as food for the reptile. Thrown into the pen, many of the heads sank into the muck of the stream bottom, and the crocodile did not eat them. About 15 years thereafter, muck was dug from the pen and several redfish skulls recovered. They were jet black in color, extremely

hard, and somewhat heavier than ordinary redfish skulls of comparable size. After months of drying, they lost a little weight, and parts of them became lighter in color. Nevertheless, they are still remarkably heavy and indurated, with the smooth surface and dark coloration typical of fossil material from many parts of Florida. They seem to be more heavily mineralized than some of the mammoth and mastodon bones found at the Bon Terra Farm site (Neill, 1953). They are far more heavily mineralized than most of the remains from the lower, preceramic levels of Indian shell middens in Florida (Neill, Gut, and Brodkorb, 1956).

A second instance of rapid petrifaction was observed by Mr. James M. Boyles, of the Department of Biology, University of Alabama, and myself, at Lake Jessup, Seminole County, Florida. At the edge of the lake we encountered three stumps of the cabbage palm (*Sabal palmetto*). The trees had been sawed off, neatly and squarely, obviously with a metal saw. The stumps sprang from the same ground level as the many living cabbage palms about them, and could scarcely have been much older; yet they were so heavily mineralized that they could not be scored, much less cut, with a knife. When rapped with a metal knife butt, they rang like stone. Clearly, petrifaction had taken place within a few decades. Certain rural residents later told me that they occasionally found mineralized stumps about lake margins, and prized fragments of these stumps as whetstones.

A third example of rapid mineralization was brought to my attention by Mr. C. E. Burkhardt, of High Springs, Florida. On the surface of an Indian midden he picked up two cut sections of mammal femur. Each is obviously the bone from a "round steak," and had been cut with a saw, the marks of which are still plain. The bones, probably left by modern picnickers, are more heavily mineralized than fossils from some Pleistocene sites. Presumably the midden soil was unusually rich in minerals.

It is not surprising to find evidence of extremely rapid petrifaction in Florida, especially in the case of remains exposed to water. Many bones (and also palm stumps) exhibit a finely porous structure through which water will pass. Dissolved solids are thus very apt to be deposited within organic remains; and of course, many Florida waters bear extraordinarily heavy loads of salts and other minerals (Ferguson *et. al.*, 1947; Odum, 1953). Whatever the chemistry of the matter, it is evident that organic remains may become

thoroughly fossilized after relatively brief exposure to certain mineral-laden waters of Florida.

The three aforesaid instances of rapid petrifaction may be unusual. Nevertheless, it is possible to demonstrate that animal remains, postdating the Pleistocene by thousands of years, have very frequently become mineralized to an extreme degree. The prehistoric Indians of Florida often littered their encampments with bones—food remains and discarded implements. In many cases, material from archeological sites may be dated with considerable precision (Heizer, 1953). Bones no more than three or four thousand years old, collected from Indian sites along streams, are often more heavily mineralized than the remains of extinct Pleistocene animals. Bone implements which fell into streams often seem to be completely mineralized and stone-like in consistency. In many Florida waters, a few millennia, if not a few centuries, commonly suffice to bring a bone to its maximum possible degree of petrifaction. As a matter of fact, the bone litter of Indian encampments need not be submerged in order to mineralize within a few millennia. The situation at South Indian Field, Brevard County, is quite typical of many archeological sites in Florida. Animal remains from two excavations at this locality were studied by Houck (1951). Bones from the lower levels of the excavations were "often dark, heavy, encrusted with calcareous material, and themselves mineralized" (*ibid.*, p. 51). The lower levels date from what archeologists now call Orange, Late times, as shown by the presence of a characteristic pottery, Orange Incised (Rouse, *op. cit.*). This ware made its appearance about 450 B. C., and its use was discontinued in eastern Florida around 150 B. C. (Goggin, *op. cit.*). In other words, at this site the remains of numerous animals had become heavily mineralized in something less than 2500 years.

Conversely, Pleistocene remains are sometimes but lightly mineralized. Bones of the American mastodon, Florida saber-tooth, Florida short-faced bear, etc. are of Pleistocene age by definition. Frequently they are very lightly mineralized, as examination of any extensive paleontological collection will show. Of course, one sometimes encounters the statement that the Pleistocene animals may have survived longer in Florida than elsewhere (*e. g.*, Gidley and Loomis, 1926; Wormington, 1949, p. 133). However, this guess stemmed from efforts to prove a contemporaneity of man

and extinct animals in Florida, and to explain away the occurrence of relatively modern Indian artifacts (such as pottery) in a supposedly undisturbed Pleistocene stratum (*cf.* Sellards, 1916, pp. 123, 159-160 with Rouse, *op. cit.*, pp. 162-165, 235-236). The fortuitous nature of the association has since been demonstrated (Rouse, *op. cit.*) to the satisfaction of most Florida archeologists, and there is no reason to suspect that the Pleistocene fauna persisted in this state longer than in other parts of North America. In fact, the actual evidence points mostly in the other direction. Along the water courses of eastern North America, including Florida, are found great heaps of mollusk shell, the refuse middens of Indians. The deeper levels of the larger middens date from what archeologists call preceramic Archaic times. Radiocarbon dates for a number of localities in the Southeast reveal that the preceramic Archaic began more than 7000 years ago. Oldest radiocarbon dates for the Southeastern Archaic are 7374 plus or minus 500 years (Johnson, ed., 1951), and 7150 plus or minus 500 years (Kneberg and Lewis, no date). Archaic and later sites often are rich in the remains of animals, and these are always of the modern species; numerous site reports attest to this fact. Bones of the extinct Pleistocene animals, in Florida at least, clearly are older than the Archaic middens, older than the Indian artifacts and debris to which reference has been made.[2]

Thus it is possible to state with assurance that the degree of fossilization is not necessarily a criterion of age; it varies with the amount of dissolved minerals to which a given bone has been exposed, and probably with the bone's structural capacity to take up minerals. This conclusion is fairly obvious; nevertheless, it has been widely ignored. The foregoing discussion has thus appeared necessary. Modern streams, which often cut through recent and Pleistocene deposits in Florida, are apt to bring together remains from both periods, for debris tends to collect in spots along stream beds, either in pockets or in areas where the current is slowed. It is not unusual to find in one spot the bones of both extinct and modern animals, Indian artifacts, the refuse of early 19th Century

[2] At several localities in the western United States, human remains and artifacts have been found in definite association with the bones of extinct animals. Where dated by radiocarbon, these paleo-Indian sites are older than the Eastern Archaic. The circumstance has little bearing on the present argument, which is concerned with the establishment of a modern fauna in Florida by Archaic times.

inhabitants, and the debris of present-day picnickers (Neill, 1952). A mastodon bone washed into the stream by last week's freshet may conceivably be less mineralized than, say, an opossum bone cast into the water by an Indian a few centuries ago. The fossilized remains of modern species, recovered from Florida stream beds, cannot safely be assigned to the Pleistocene even though they may accompany similarly fossilized remains of extinct species.

Animal remains may be deemed of Pleistocene age if they are of the extinct species whose presence characterizes this epoch; and the remains of living species may be assigned to the Pleistocene if they were found *in situ* within an undisturbed formation of this time period. In some parts of the world, heavy mineralization may also imply a Pleistocene or earlier dating, although in Florida petrifaction is not a criterion of age. Probably no author has expressly stated that he assigns certain remains to the Pleistocene of Florida solely on the basis of their mineralization. Nevertheless, as authors have commonly made such assignments without corroborative faunistic or stratigraphic data, there must often have been a tacit assumption that mineralization justified a Pleistocene rather than a recent dating. Certain "Pleistocene" records are thus questionable, and must be reconsidered.

For example, the modern beaver (*Castor canadensis*) has been reported from the Pleistocene of Florida on the basis of mineralized remains from Ichtucknee Spring run, Columbia County (Simpson, 1930). The remains were associated with those of elephants, mastodon, etc., all presumably of Pleistocene age, as well as with those of the modern opossum, raccoon, otter, and deer. Sherds of Indian pottery are also very common in the bed of Ichtucknee Spring run, along with the mastodon and other remains. No authority would now argue for a contemporaneity of the Pleistocene remains and the Indian pottery; Florida sites far antedating pottery yield only the remains of modern species (Neill, Gut, and Brodkorb, *op. cit.*). The association in a stream bed of pottery and the bones of extinct animals is no more remarkable than the presence of pop bottles in the same place. A question therefore arises: Are the beaver remains contemporaneous with those of the elephants, or could they be the refuse of later Indian encampments? The degree of mineralization will not aid in solving this problem; a survey of the literature, and of collections, is suggestive, however. In a talk before the Florida Anthropological Society, Mr. H. James Gut

summarized what was known of the beaver in prehistoric Florida (Gut, 1952). The only finds tentatively attributed to the Pleistocene were from stream or lake bed deposits (Ichtucknee Spring, Lake Monroe, and the St. Johns River). The antiquity of these finds is therefore open to question; and Gut quite properly listed them as "possibly Pleistocene." On the other hand, remains of the modern beaver have been recovered from at least four Indian sites in peninsular Florida (Neill, Gut, and Brodkorb, *op. cit.*), in a context dating no earlier than about 1550 B.C. Apparently the species was absent from the peninsula during most of the preceramic Archaic, making its appearance as this archeological period was drawing to a close. Of course, the modern beaver may some day turn up in the Florida Pleistocene. However, one can interpret a situation only in the light of present knowledge, which suggests that *C. canadensis* did not enter the state until the recent period.

Simpson (*op. cit.*) reported the muskrat (*Ondatra zibethica*) from the Pleistocene of Florida on the basis of specimens from Ichtucknee Spring run. Remains of the round-tailed water rat (*Neofiber alleni*) were also found in the Ichtucknee and assigned to the Pleistocene. Simpson (*op. cit.*), Lawrence (1942) and Schwartz (1953) all concluded, therefore, that the two species occurred together in Florida during the Pleistocene, although today the two are mutually exclusive geographically. The present distribution is not surprising. Being similar "in habitat and food requirements and general conditions for life" (Schwartz, *op. cit.*, p. 22), they are much more apt to be vicariants than competitors, in accordance with a general ecological rule. The Ichtucknee muskrats may be of Pleistocene age, having been described as a subspecies differing slightly from all modern ones in certain skull characters (Lawrence, *op. cit.*). However, in this connection it would be interesting to know the subspecific identity of the muskrat reported from an Indian site in North Florida and dating from around 500 B.C. (Neill and Bullen, 1955). At any rate, it does not follow that the water rats from Ichtucknee are of the same age as the muskrats. *Neofiber* bones are common at Indian sites, and those from Ichtucknee might be contemporaneous with the pottery found therein. Furthermore, granting that both water rat and muskrat date from the Pleistocene, there is yet no certainty that they are of equal age. During a peak of glaciation, cold weather may have forced the water rat into South Florida and enabled the muskrat to enter North Florida;

with the returning warmth of an interglacial or postglacial period, the water rat may then have advanced northward as the muskrat retreated. Simpson (*op. cit.,* pp. 1-2) admitted, "The association of artifacts and extinct animals [at Ichtucknee] is not important, in view of the type of deposit;" but obviously the association of *Neofiber* and *Ondatra* in the same deposit is equally unimportant from a temporal standpoint. Judging from the literature, remains of these two rodents have not been found together in Florida outside a stream bed. Cooke (1926) did mention muskrat at the Melbourne site but apparently he had *Neofiber* in mind, for subsequent tabulations of the Melbourne specimens included only the latter. Lawrence (*q. v.*) cited several authors who had found only *Neofiber* at various rich Pleistocene localities in Florida. One receives the impression that these two species were vicariants in the Pleistocene, just as at present. Here again, future collecting may negate my interpretation; but at least one may advocate extreme caution in accepting numerous "Pleistocene" records based solely on mineralized remains from Florida stream beds.

Brattstrom (1953) listed many supposed Late Pleistocene records of amphibians and reptiles from Florida. Apparently he did not investigate the sites involved, but relied on Cooke's (1945) summary of Florida geology. Later papers were not examined. Brattstrom's records included vertebrae of the large, burrowing salamander, *Amphiuma means,* from Stratum No. Three at Vero Beach, St. Lucie County; from Seminole, Pinellas County; and from Wakulla Springs, Wakulla County. (The last locality was erroneously placed in Leon County by Brattstrom.) All these records of *Amphiuma* are open to question. The Vero Beach locality may be considered briefly. There in 1915, and again in 1916, human bones and artifacts were found in association with the remains of extinct Pleistocene animals. At that time, in the absence of modern excavating techniques and definitive archeological knowledge, it was contended that the human remains were contemporaneous with those of the extinct beasts. Viewed in the dispassionate light of modern knowledge and techniques, the situation is much clearer (Rouse, *op. cit.*). The Vero Beach site was occupied by Archaic Indians in the early part of the recent period, when the climate was relatively dry and sea level lower than at present. The Indians deposited a good bit of refuse, including the bones of modern animals as well as their own bones. They also dug a burial pit into

the underlying Melbourne (Late Pleistocene) formation, thus commingling Pleistocene and recent material. Later Indians occupied the site during what archeologists call the Malabar I′ period, which began not long before the Christian Era. They dug a large, deep well at the site, and in so doing commingled their own refuse with that of the earlier inhabitants and with animal remains originally from the underlying Melbourne formation. Sea level gradually rose, and with it the water table; the site eventually became a marsh, and the Indians abandoned it. It was a marsh at the beginning of the 20th Century, when canals were dug to drain it; and many of the "Pleistocene" finds were taken from spoil banks of the canals. Much of the material was collected by enthusiastic but untrained local residents. In view of the extreme disturbance at the Vero Beach site, by prehistoric and modern man, one could not assign the *Amphiuma* remains to the Pleistocene except on the dubious basis of their mineralization (which in any event is not impressive). *Amphiuma* is an inhabitant of bogs and marshs; and I suspect that Brattstrom's "Pleistocene" remains are actually those of specimens dwelling in the marsh that formed within the Christian Era. Furthermore, *Amphiuma* is strikingly modified, both in anatomy and physiology, for subterranean life; specimens have been dug from beneath 15 feet or more of mucky deposits. No doubt today, near Vero Beach, many an *Amphiuma* leaves its remains somewhere along the contact plane between the Melbourne formation and the underlying Anastasia coquina, there to mineralize in a few centuries!

The Wakulla Springs site merits only brief discussion, in view of the previous comments on mineralization in Florida waters. Wakulla is rich in minerals which color bones a characteristic bluish shade. Mr. V. J. Allen, of Dunnellon, Florida, recovered from the spring bed many Indian artifacts of bone. Some of these, now in my possession, are completely petrified, having the consistency of stone. It is probable that *Amphiuma* remains, no older than these artifacts, would be comparably petrified. The heavily mineralized bone objects have included splinter awls, long and short bone points, and decorated pins of several kinds; these are more or less characteristic of Archaic times, especially the latter Archaic. It is fairly safe to conclude that a mineralized bone from Wakulla need not be more than 2500 years old, if that. A Pleistocene dating

cannot be accepted for any animal remains from this spring, except those of extinct species which are Pleistocene by definition.

The material labeled "Seminole" came originally from the bed and flood plain of a stream, Joe's Creek, now in St. Petersburg. On two occasions, dredging of the creek uncovered animal remains, including both extinct and modern species. The abundance of extinct animals at Seminole implies that most of the remains truly date from the Pleistocene (Simpson, 1929). However, I would hesitate to accept the *Amphiuma* record as being of Pleistocene age, for several reasons. First, Seminole is another stream bed locality; second, it has been disturbed by dredging; third, there is some evidence that the deposits have been reworked by nature. Opportunities for a commingling of recent and Pleistocene material have been too numerous to permit unquestioning acceptance of a Pleistocene dating in the case of a paludicole like *Amphiuma*.

Seminole, Wakulla, and Stratum Three at Vero Beach have been discussed with special reference to *Amphiuma;* but obviously, most of the remarks are applicable to the remains of other modern species from these localities. As noted, the general run of material from Seminole is apt to be of Pleistocene age; but, since remains of two periods have been mixed there, one cannot accept unreservedly the Pleistocene dating (Brattstrom, *op. cit.*) for the vertebrae of several modern amphibian and reptile species collected along the creek bed. Some of these species are characteristic of mucky streams; and in fact, the entire herpetofaunal assemblage reported by Brattstrom from Seminole would be expected in the general vicinity of the creek valley today. Of course, this circumstance does not prove anything; but the muck of the stream bed should yield the remains of at least a few animals that died in recent times.

A vast amount of mineralized "Pleistocene" material, reported from stream beds or other water-laid deposits of Florida, must be viewed with suspicion. Various authors have, without comment, ascribed a Pleistocene dating to the remains of modern species collected from Crystal River, Wakulla, Ichtucknee, the St. Johns River, numerous canals, Sarasota Bay, etc. It hardly seems worthwhile to publish additional records of this nature.

And as for Stratum Three at Vero Beach, almost all of the mammal remains therefrom were of modern species, according to the original excavator; the exceptions included a few teeth which, being broken, clearly indicated some disturbance at the site (Sell-

ards, (*op. cit.*, pp. 158-159). Rouse's (*op. cit.*) explanation of this circumstance has been accepted by Deevey (1950), and by archeologists who are specialists in the interpretation of a stratigraphic profile. In other words, remains from Stratum Three are mostly of recent age, and just a few bones, intrusive from Stratum Two, date from the Pleistocene. The degree of mineralization will not aid in segregating the older specimens. This means that most of the specimens from Stratum Three, assigned by various authors to the Pleistocene, are probably of recent age. Included in this category are plants, fishes, insects, frogs, salamanders, turtles, the American alligator, lizards, snakes, birds, and mammals. All but one of the plant species, and some of the animals, apparently were found in the upper part of Stratum Three; *i. e.*, in the muck bed that formed after the site had been abandoned by Indians of the Malabar I′ period. These remains should date from well within the Christian Era. Fortunately, some of the species involved have been collected elsewhere from actual Pleistocene situations, and need not be excluded from the Florida list for that epoch.

Workers in many fields are indebted to paleontologists, who go about the difficult task of identifying fragmentary remains. Few problems are more interesting, or of more widespread concern, than the faunal turn-over marking the zoological end of the Pleistocene. In general, this problem and allied ones are most apt to be solved by on-the-spot investigators who can interpret a given site in terms of the latest geological, paleontological, ecological, and sometimes archeological advances.

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A NEW SPECIES OF *BUFO* FROM THE PLIOCENE OF FLORIDA [1]

Walter Auffenberg
University of Florida

Very little information is available concerning the micro-vertebrate fauna of the Florida Pliocene. Recent careful washing and screening of a Middle Pliocene (Hemphillian) deposit near Haile, Alachua County, Florida (Locality Haile VI, A; SW ¼ of Sec. 24, T9S, R18E) has yielded a few remains of small reptiles and amphibians. These include the glass lizard, *Ophisaurus ventralis* (Auffenberg, 1955) and two extinct species of sirenid salamanders (Goin and Auffenberg, 1955). The few anuran remains collected at this locality are considered in the present paper.

Of particular interest are fragmental remains of a toad apparently representing the genus *Bufo*. The morphological characteristics exhibited by the available elements are sufficiently distinctive to warrant specific nomenclatorial designation. The new form is named in honor of Dr. J. A. Tihen, who first brought attention to the extinct Tertiary amphibians of Florida by describing a new species of toad, *Bufo praevius*, from the Thomas Farm Miocene.

Bufo tiheni sp. nov.

Holotype.—No. 5203, University of Florida. A fragmentary sacral vertebra (Fig. 1), collected by Walter Auffenberg, 1954.

Horizon and Type Locality.—Middle Pliocene (Hemphillian), Alachua formation, locality Haile VI, A (SW ¼ Sec. 24, T9S, R18E), near the village of Haile, Alachua County, Florida.

Referred Specimens.—UF 5095, a fragmentary sacral vertebra and UF 6363 and 6479 representing four fragmentary ilia. All specimens collected from the same locality and horizon.

Diagnosis.—A Pliocene *Bufo* characterized by the relatively long centrum; the shallow ventral groove between the condyles; the dorso-ventrally compressed centrum and the horizontally oval glenoid cavity; diapophyses relatively close together; transverse dorsal ridge of the neural arch angular, but obtuse, centrally located

[1] A joint contribution from the Department of Biology and the Florida State Museum.

between the antrior and posterior edges of the neural arch. Ilium with a high dorsal prominence, with a roughened, slightly laterally compressed protuberance at the upper end, and a keel beginning at the shaft and extending up the dorsal prominence on both its anterior and posterior surfaces; dorsal prominence even with, or slightly anterior to the anterior edge of the acetabulum, even with the ventroanterior portion of the acetabular expansion.

Discussion.—The sacral vertebrae and ilia possess the typical bufonid characteristics: i.e.: procoelus centrum, with two large, salient condyles and the diapophyses expanded. The ilia are with-

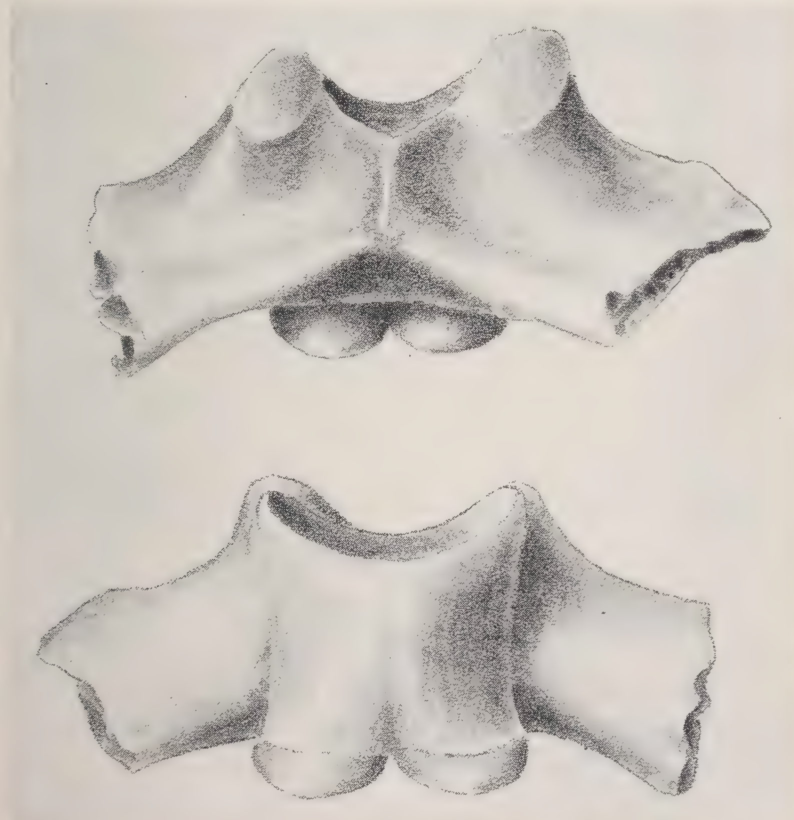

Figure 1. U. F. 5203, the type of *Bufo tiheni* nov. sp. Sacral vertebra collected in 1954 by Walter Auffenberg from locality Haile VI, A (T9S, R18E, SW¼ of Sec. 24), near the village of Haile, Alachua County, Florida. Middle Pliocene (Hemphillian), Alachua fm. ca. x 12.

out a dorsal crest, but provided with a dorsal prominence which is directed dorsally, rather than laterally. Of particular interest however, is the fact that the fossil elements are readily separable from the contemporary eastern representatives of the genus (*B. woodhousei* and *B. terrestris*) and approach those of some of the toads of western United States much more closely. This is particularly evident in the height of the dorsal prominence, which in *tiheni* is high and spine-like, as in *compactilis, punctatus* and *cognatus.* From these species the fossil form is largely distinguished by the fact that the keel is continuous over the top of structure (Fig. 2). The keel, when present at all, is not nearly as well-developed in the Recent forms. It is absent in *Bufo praevius* from the Miocene of Florida, which also differs from *tiheni* in possessing a low prominence similar to that in both *woodhousei* and *terrestris* (Tihen, 1951).

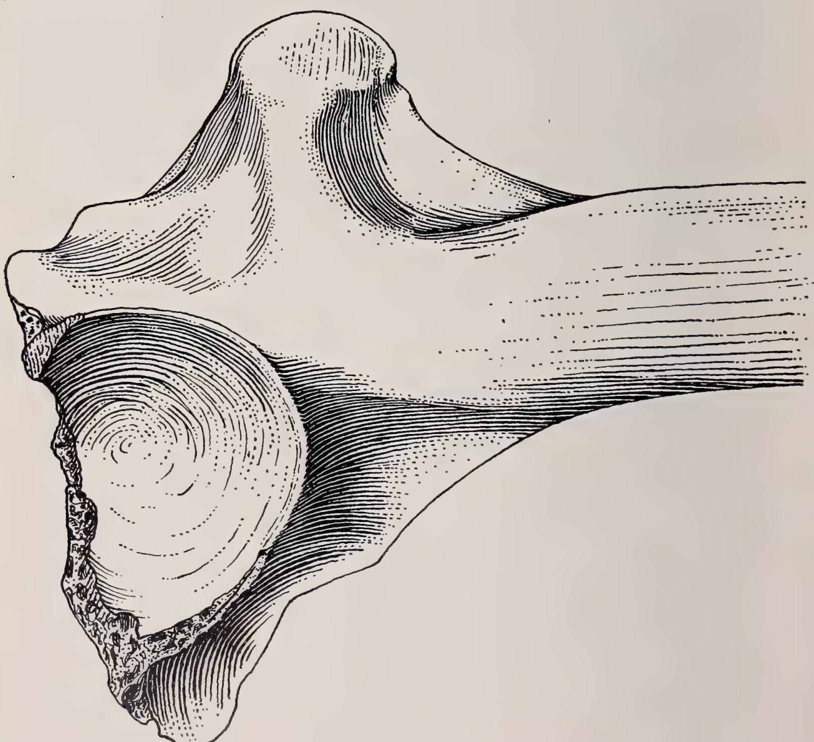

Figure 2. U. F. 6363, Ilium referred to *Bufo tiheni* from the same locality and horizon as the type, illustrating the high, spine-like dorsal prominence. ca. x 21.

On the basis of the cranial crests *praevius* has been shown to be close to *woodhousei* (Auffenberg, 1956). The latter is known from Sangamon interglacial deposits of Kansas (Tihen, 1954). Brattstrom's (1953) record of this species from Florida is erroneous, and the element on which he based his identification is referrable to *Bufo terrestris*. Furthermore, Stratum 3 of Vero Beach, Florida, is now generally considered to be Recent in age.

On the basis of its ilial characters *Bufo tiheni* is approached most closely among fossil toads by forms "A" and "B" of Taylor (1942) from the Upper Pliocene of Kansas. However, the keel, so evident in *tiheni*, is lacking in the Kansas material. The latter are evidently related to the *compactilis-cognatus* complex.

The sacral vertebrae of *B. tiheni* are considerably different from any modern forms I have examined; largely in the greatly compressed centrum, forming a horizontally oval glenoid cavity, and the relatively short distance between the articular facets of the prezygapophyses.

From *woodhousei* and *terrestris* the fossil sacral elements differ chiefly in the characters mentioned above and in having the transverse dorsal keel of the neural arch more centrally located, instead of being placed closer to the posterior edge of the neural arch, and in possessing a greater angle between the two dorsally projected laminae making up the ridge. As regards the latter, *tiheni* is most closely approached by some specimens of *B. compactilis*.

The vertebrae differ from those of *Bufo hibbardi* and *B. arenarius*, described by Taylor (1941) from the Middle Pliocene of Kansas largely in that the elevated ridge on the dorsal surface of the neural arch is well-developed, but rounded, forming an angle greater than 90°; the prezygapophyses are smaller and closer to one another; the diapophyses are narrower and directed more posteriorly; and the groove on the ventral surface of the centrum is restricted to the area between the posterior paired condyles (Fig. 1.), instead of extending more anteriorly.

That *Bufo tiheni* is apparently related to both fossil and Recent species of *Bufo* now found in western North America is of particular importance, especially since the lower Miocene form from Florida is clearly related to the *terrestris-woodhousei* complex.

Certain elements of the Recent reptilian fauna of Florida are highly suggestive of western forms and apparently represent immigrant populations. This is especially true of such genera as

Crotalus, Pituophis, Masticophis, etc. In the West these elements reach their peak of abundance and diversification. In eastern United States they are more or less restricted to open dry forest conditions. Since these or related forms are absent in the Miocene deposits of Florida, but present in the Pleistocene deposits of the State, one would infer that they probably reached this area during, or near, the Pliocene.[2] The fact that *Bufo tiheni,* apparently related to toads now found in western United States, is found in the Pliocene supports this view. The possible occurrence of other species with western affinites, since extinct, in the Pliocene of Florida cannot be denied. Unfortunately, little is known of the rodent fauna present in the peninsula at that time, and the bird fauna described from this period (Brodkorb, 1955) is largely marine or littoral.

Rana cf. *pipiens*

The material referred to this genus and species from the same locality includes six fragmental ilia (UF 6481, 6362, 6471-2, 6474 and 5097) one complete humerus (UF 6486) and one fragmental sacral element (UF 6361).

Although fragmental, the ilia do not seem to represent *grylio, heckscheri* or *catesbeiana.* This is largely based on the shape of the dorsal crest. In these species the angle between the longitudinal axis of the ilial shaft and the posterior edge of the dorsal crest from the top of the crest to the base of the dorsal portion of the acetabular expansion is less than in the fossil ilia. In addition, the postero-dorsal portion of the crest is bent inward, whereas it is straight in the fossil specimens.

On the other hand, the fossil ilia are very similar to those I have examined in *Rana pipiens, R. clamitans, R. capito, R. sylvatica* and *R. palustris.* From *clamitans* the fossil ilia differ in a minor fashion in that the region just anterior to the acetabulum is wider and the angle between the axis of the shaft and the posterior edge of the dorsal crest is somewhat greater in specimens of comparable size. From above the posterior portion of the dorsal crest of *clamitans* is usually bent inwards very slightly. It is straight in all of the available fossil ilia.

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[2] A fossil crotalid from the Pliocene of Florida is now known (Auffenberg, Thesis).

From *sylvatica* the fossils differ chiefly in their larger size, but this is admittedly a poor diagnostic character.

The ilia of *pipiens, palustris* and *capito* are very difficult, if not impossible to separate. Unfortunately, the fossil sacrum is so broken that proportional measurements of this element, used to considerable advantage by Tihen (1954) in separating several species of *Rana,* cannot be utilized.

Apparently the deposit represents an old stream channel. *Rana capito* is now at least an inhabitant of dry forest conditions, leading, for the most part at least, a terrestrial existence. There is little or no suggestion of a dry forest fauna in the deposit, most forms being aquatic, or of a type frequently found in mesic, though perhaps open forest conditions.

Rana palustris and *R. sylvatica* are more northern frogs, not found in Florida at the present time. There are no definite northern faunal elements in the deposit. According to Berry (1916), on the basis of floral remains from another Pliocene locality in Florida, there is little reason to assume that climatic conditions were very different from those existing in the area today.

At least at the present time *Rana pipiens* is a wide spread form that inhabits a variety of ecological conditions. Based on the known facts it seems reasonable to refer the fossil ilia to this species.

The relationships of the Florida form with the other North American Pliocene ranids (LaRivers, 1953; Zweifel, 1954; and Taylor, 1942) remain unknown.

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A FISHERIES STUDY OF LAKE PANASOFFKEE, FLORIDA [1]

Harold L. Moody
Florida Game and Fresh Water Fish Commission
Leesburg, Florida

Introduction

Lake Panasoffkee was known to have a large population of non-game fishes (Moody 1954) and fishing success for game species was popularly believed to be suffering a decline. Late in 1953 it became possible for the Commission to undertake, through Dingell-Johnson Federal Aid funds, a program of investigation based on the removal of non-game or rough fish species by haul seine. Sport catch studies were carried on concurrently with removal. The purposes of the investigation were dual: (1) to determine the effects of such removal on both sport catch and on total lake populations, and (2) to provide useful information of an ecological nature for fishermen.

Field Methods

Chemical and Physical Observations

Records were kept of water level fluctuations and water qualities. Chemical methods at the netting sites included routine dissolved oxygen, free carbon dioxide, pH, and water temperature determination (Welch 1948); subsequently chloride, sulfate and alkalinity tests (Amer. Pub. Health Ass. 1955) were also performed. No planktal studies were made, but notes were kept on the relative changes in water color as they appeared to the eye of the observer.

Fish Removal

Fish removal during the thirteen months between October 19, 1953 and October 26, 1954 was accomplished by use of a conventional Florida haul seine. The net was kept at a constant length, 1,000 yards, with a constant minimum mesh size of 3 inches stretched measure. In the 900 yard wing, of 4⅜ inch stretched mesh measurement, the depth was 55 meshes, while the 100 yard

[1] Publication of this study has been made possible in part by funds provided by Federal Aid to Fisheries Restoration through the Dingell-Johnson Act. Florida Project F-5-R.

footing circle and pocket (of 3 inches, stretched mesh measurement) consisted of webbing 70 meshes deep. Operation has been described (Dequine 1951; 1953); a review of the technique will be of value. From a launch-towed seine boat one end of the sectionalized net is anchored to the lake bottom. The seine boat is then drawn away from the anchored end; this movement results in pulling the net off the seine boat into the water. The degree of net curvature, predetermined by distance from shore, character of bottom and weather, governs the amount of water swept. The towed end is gradually pulled by the launch toward the anchored end until the seine completely encloses a circular area. Then follows removal of sections in such a manner as to maintain unbroken the circle formed by the net, until finally the area surrounded is reduced to zero and the net to its final component, the pocket. This pocket was cylindrical in shape, 210 meshes (50 feet) in circumference and 180 meshes (45 feet) in length. The fishes confined in it are dipped out after its mouth is spread between two fish boats.

Non-game fishes are placed in a fish boat to die and game fishes are released. Sample dipnets of fish are retained in a live-well boat for catch analysis. Counts and weights are made of the fishes from these dipnets. Length frequency, length-weight and gonad examinations are made; some fishes are tagged and released.

A crew of three commercial fishermen familiar with haul seine methods was employed on a monthly basis to manoeuvre the net and dispose of the fish. The writer supervised the operations and gathered the data. Sportsmen visitors at the net frequently facilitated data-gathering by recording information as obtained.

Efforts were made in the operations to vary the locations worked so as to have haul seine samples from all nettable areas of the lake every five hauls.

Catch summaries were obtained by applying representative dipnet weight and number proportions to total quantities of gizzard shad taken in the haul; garfishes, bass and species of minor incidence were generally counted and weighed. All measurements were total length, to the nearest half inch, and weights were in pounds.

Tagging Methods

Fishes tagged were obtained from the haul seine and from wire baskets placed in peripheral areas. Two types of tags were em-

ployed: metal cattle tags applied to the maxillary (Dequine 1950), and experimental disc-dangler type plastic tags loosely attached outside the body by means of a surgical needle with nylon thread. The bulk of the tagging was done in Lake Panasoffkee; fishes were also tagged in the Withlacoochee River.

Creel Census

A study of sport fishing was planned and executed. Lake Panasoffkee, Outlet River and the nearby Withlacoochee River northward to Carlson's Landing were divided into six equivalent areas. The region thus defined was patrolled by an officer in an outboard motor boat at regular intervals: one hour of time was allotted to be spent in each area every day of census. In order to further eliminate bias starting time and starting points were daily rotated according to a fixed schedule. One of the six points marking the limits of the areas involved was each in turn made the starting point for a day's census. Times for beginning the patrol alternated between six, seven, eight, nine, ten, eleven A.M., and twelve noon. The effective daily time period sampled by the census therefore included the twelve hour period between 6:00 A.M. and 6:00 P.M. All persons observed fishing in the areas at the time of census were interviewed.

Upon contacting a fishing party the officer noted the number of people in the boat fishing, the number of fish caught, and their sizes. He determined through conversations with them the length of time they had been fishing and the kind of fish they were trying to catch. Three categories of fish were reported: bass, crappie, and bream. The term bream included shellcracker, bluegill, warmouth, redbreast, and stumpknocker. If the fishermen interviewed had been unsuccessful that fact too was recorded.

Creel records collected by this method over eighteen consecutive months, dating from the last week in March 1954 to the last week in August 1955, are discussed.

Description of the Region

Lake Panasoffkee

Geologically Lake Panasoffkee lies on the Penholloway terrace whose altitudes are 70 to 42 feet above sea level (Cooke 1939). Geographically it is located approximately at latitude 28° 45′ N and

longitude 82° 15′ W in townships 19 and 20 south, range 22 east in Sumter County. The lake has been briefly described (Moody 1954). It has an area of about 7 square miles, is long and narrow in shape with its long axis in a northwest-southeasterly direction. It is spring fed. The Panasoffkee group of three or more springs unite to form Panasoffkee River entering the lake from its south side. This river when measured July 26, 1946 had a flow of 40.2 cubic feet per second, or 26 million gallons per day (Ferguson 1947). No measurements were made during the survey period. It is believed that the flow then was considerably reduced. Two watercourses enter Panasoffkee from the north: Big Jones and Little Jones Creeks. They are fed by smaller springs and by a considerable amount of surface water run-off in the wet season.

The shore on the east is low and swampy with numerous marshy inlets, some of which are connected with Panasoffkee River. Because of the low topographic relief no camps or dwellings are present on the immediate eastern shore. The west side is of higher hammock land. Eight sport camps were located here and three on Outlet River at the time of study. As of the time of writing at least four more camps and the beginnings of residential subdivisions have been added.

Outlet River leaves the lake from the middle of the west shore. It is a stream approximately 50 yards wide which flows into the Withlacoochee River about three miles to the west. Because of the volume of spring water flowing into the lake, a current is nearly always evident in Outlet River. At extremely rare intervals however, when the water level of the river undergoes an extreme and rapid rise and that of the lake does not, Outlet River reverses its flow and water from the Withlacoochee enters Lake Panasoffkee. This has happened twice in the past nine years. The water level in Panasoffkee appears to be normally about a foot higher than that of the Withlacoochee River in a nearby area (Moody 1955).

Lake Panasoffkee was sounded with an electronic ("White") echo sounder April 23 and 24, 1955. Average depths through the middle on the long axis were about five and one-half feet. Increasingly shallower depths were recorded traveling toward the east shore. At a distance of about three hundred yards from the marshy shoreline, water depth was one and one-half feet. From the center towards the west shore the water deepened, reaching a maximum of nine feet near the mouth of Outlet River. The deep water of

the lake follows a contour usually within twenty-five yards of the west side.

The bottom consists of a deep, fine yellowish inorganic silt underlain by sand, blue clay and limestone. Near the edges of the shore and in the sloughs and runs, deep black organic muck overlays sand, silt and soft limerock. Underwater vegetation consists chiefly of *Vallisneria americana.* Extensive beds are present in the wide expanses of shallow water on the east side and at the north and south ends, and in narrow areas close to the shore on the west side of the lake. Coontail moss (*Ceratophyllum*) is present in smaller quantities in the deeper areas. Sawgrass (*Mariscus*), water stargrass (*Heteranthera dubia*), pickerel weed (*Pontederia*), bladderwort (*Utricularia*), arrowhead (*Sagittaria lancifolia*), button bush (*Cephalanthus occidentalis*), water willow (*Dianthera lanceolata*), and cypresses (*Taxodium*) are prominent emergent and shoreline plants while water lettuce (*Pistia stratiotes*) and duck-weed (*Wolfia*) are outstanding examples of the floating vegetation. A small quantity of water hyacinth (*Eichornia*) exists but its growth is not vigorous.

Withlacoochee River

The Withlacoochee is a narrow sluggish river over a hundred miles long which rises in Polk County and flows northward on the western mid-section of the Florida peninsula to empty into the Gulf at Yankeetown (Moody 1955). Wide shallow parts of it within a fifteen mile length of its central portion in the Panasoffkee region were sampled by haul seine. The river in this area is generally deeply stained by decaying vegetation and muck on its shores which are heavily wooded and low. The bottom in the portions seined was sand and black mud. A thin bladed *Vallisneria* grows thickly in some shallow sections, and at times the river is clogged from bank to bank with water hyacinths.

Chemical and Physical Data

Table 1 presents chemical and physical information obtained between October 1953 and February 1957. Methyl orange alkalinity tests were not made until the time of the latest Outlet River reversal phenomenon (Moody 1955); consequently it was necessary to make tests of Panasoffkee water much later under normal conditions. Panasoffkee water is markedly alkaline in nature, with a total

Methyl Orange alkalinity of 119 ppm., and a pH of about 8.0; Withlacoochee water is neutral to slightly acid: M.O. alkalinity 26 ppm, pH about 7.0. Hydrogen-ion concentrations in Lake Panasoffkee varied with the temperature of the water, the amount of sunlight and the quantity of phytoplanktal material present. The highest recorded pH of 9.5 was obtained one late afternoon in early fall when water temperature was high: 86° F.; the lowest, 7.6, occurred in the morning of a day in late December when water temperature was 60°. pH values showed a tendency to decrease through the fall and winter months and augment in springtime and summer when phytoplanktal coloring was most marked. Buffer action was pronounced. The water was often supersaturated with dissolved oxygen under conditions of high temperatures and heavy bloom. Panasoffkee water is nearly salt-free: chlorides exist at the rate of 3 parts per million; the sulfate radicle is present at 51 ppm (Table 1).

Monthly water levels from a station in Lake Panasoffkee and mean monthly air temperatures as recorded at the nearby U. S. Climatological station of Bushnell (Comm., U. S. Dept: 1953; 1954; 1955) are presented in Table 2. Temperatures in shallow waters in Florida (Alligator Harbor) closely approximate air temperatures (Grice 1956): in the absence of adequate water temperature data these air temperatures are substituted.

Water levels in Panasoffkee receded 3.26 feet between October 1953 and August 1955. The recession rate was nearly constant. Temporary recoveries through precipitation were slight and evanescent.

Spawning Observations

The fishes taken by the haul seine were nearly all sexually mature individuals. Table 3 reviews gonad conditions and spawning observations made of the various species. The data indicate that bass spawned in March and April, crappie were spawning by April, and bluegill and shellcracker began spawning as early as March, and continued through the summer and early fall. The height of the gizzard shad spawning season occurred in March. Spawning apparently began late in January, continued through April, and ended in May. Longnose gar began to spawn in March and continued through August. More longnose gar were taken in spawning condition during April than in any other month. Most of the Florida spotted gar were observed in ripe condition in the months

of April and May; however they continued to spawn through October. A speckled bullhead in "ripe" condition was observed in May, and a spent individual was encountered in March. From the scant information on lake chub sucker, stumpknocker and warmouth it would appear the former had started to spawn in early spring and continued through early fall; and that the latter two species were in spawning condition by April.

Many bass and gizzard shad were observed close to the shore in shallow water during January and February, and garfish concentrations occured in shallow areas in the lake and adjoining creeks in March.

Effectiveness of the Haul Seine

Non-game Fish Control

In thirteen months 153 hauls were made in Lake Panasoffkee. In round numbers, 300,000 pounds of fishes were taken, 200,000 pounds of which were non-game fishes (Table 4). The water area enclosed by the average seine haul was in the neighborhood of forty acres. Had the net made 30 hauls monthly instead of its actual average of 12, it could not have covered more than one-quarter of the total area of the lake each month. Table 5 demonstrates further the futility of the haul seine as an instrument of control. Calculations from average pounds of fishes taken per acre of water seined disclose that the total weight of the fishes removed during the entire thirteen months was not quite equal to the total estimated poundage available to the net at any given moment of time. Recruitment of smaller size groups into the range of net selectivity was rapid among most species, particularly during the warm months, and further nullified effectiveness of rough fish control by the haul seine method. More gizzard shad and garfishes were taken during the last month of operation than in the month seining began (Table 6).

As a Sampling Device

Nevertheless it has been demonstrated (Moody 1954) that the haul seine is an effective tool for sampling adult fish populations. Its application however, is limited to relatively shallow waters and even bottoms. When carried on over a protracted period of time, as in Lake Panasoffkee, the operating expenses involved are almost prohibitive. It is impossible for one man to gather more than a

small fraction of the data it offers. In Lake Panasoffkee about one-third of the total water area was too shallow to be sampled by haul seine; deep silt and mud made it impracticable to pull the net by hand.

Tagged Fishes

About two thousand fishes were tagged in Lake Panasoffkee and one hundred in the Withlacoochee River during the seining period. These included individuals of all species. Recaptures of the following species were not reported: garfishes, sucker, shiner, channel and white catfish, chain pickerel, mudfish and redbreast. It is presumed that too few were tagged. Table 7 summarizes recapture data. It is observed that a considerable amount of movement took place between the lake, creeks, and the river. Most of the recaptures made in the lake were by haul seine. Two percent of the total number of gamefishes tagged were retaken by sportsmen; they captured seven percent of the tagged bass and only one percent of the tagged bream. By contrast, Dequine (1950) reported tagging 1,616 bass in the Apopka-Griffin chain of lakes and sport recaptures of 22.9 percent within a year of their release. About 4,300 bass were tagged in the St. Johns River during 1952 and 1953 (Moody and Taber, unpublished data) with recaptures of two percent within the first year. Sharply reduced numbers were reported in succeeding years; they were made during the winter months. Two bass were retaken in the St. Johns four years after tagging, one of them twenty-five miles from the tagging spot. No recaptures from Panasoffkee-Withlacoochee waters were reported later than a year and a half after tagging. One bass released in the Withlacoochee River near Lake Panasoffkee in April 1954 was caught, nearly 50 miles from the point of release, near the river mouth in October 1955.

Population estimates and rates of sport fishing harvest, although inviting comparisons, were not made from the tagged material. Loss of the experimental disc dangler tags occurred, and their red color may have made fishes thus marked more subject to predation (German 1955 raises similar doubts). Failures to report recaptures, mixing of lake and river fishes, the uncertainty of escape rates from the haul seine, recruitment by growth into net selectivity, and the scarcity in numbers of tagged fishes further preclude mechanical estimations.

Haul Seine Samplings

Amount and Composition of the Catch

Tables 4 and 6 show total quantities taken and Table 8 offers a comparison of the catch in 1951 (Moody 1954) with the '53-'54 period in Lake Panasoffkee. Gizzard shad, garfishes and shellcracker constituted the bulk of the catch on both occasions. The average pounds taken per haul during the latter period amounted to less than half that of 1951. This was due in part to the decreased sizes of the bass, crappie, bluegill and shellcracker (Table 9) but was primarily a reflection of sharply reduced quantities of garfishes. The proportion by weight of garfishes in the catch decreased by 19% while that of the gizzard shad increased by 18%. The proportionate quantities of bass, crappie, bluegill and shellcracker, the major gamefishes, showed no appreciable changes in weight composition.

Tables 10 through 30 present length-frequency and length-weight measurements for the principal species taken in Lake Panasoffkee. Progression in size classes over the time period is evident with some species as is also recruitment by growth into net selectivity. Length-weight data in many cases affirms spawning condition.

Table 31 summarizes the catches made in the Withlacoochee River in 1951 and 1954. Smaller total quantities were taken in the unit haul here than in Lake Panasoffkee, gizzard shad were fewer. The coloration of the fishes was much darker than in Lake Panasoffkee: the bottom was dark and the water was deeply stained from decayed vegetable debris.

Periodic Fluctuations

Periodic fluctuations in amounts of fishes available to the haul seine have been regularly observed in Florida waters (Dequine 1951, 1953; Huish 1954). They occurred in Lake Panasoffkee. Tables 32 and 33 list average numbers of the principal species taken per haul per month as bases for statistical analyses. The data have a weakness in that the numbers of hauls made per month were not constant. They varied from 6 to 19, however the alternative of arranging the material into periods of equal numbers of hauls would have resulted in widely disparate time intervals.

Several acute fluctuations of specific abundance occluded correlation between total numbers of fishes and water level; nevertheless

fewer fishes occurred as the water level receded. The general decline in fish populations appeared to be directly related to the lowering water level. The correlary conclusion that the net was fishing on the bottom throughout the operational period is also evident.

The coefficient of correlation between water level and numbers of golden shiner was highly significant: r, .951; df 11. As the water receded large patches of exposed *Vallisneria* died and shiners disappeared from the seining areas. Bait fishermen found it difficult to get them in the lake during the warm months.

Chub sucker frequency displayed a negative relationship toward water level which was found statistically significant: r, —.838; df 11. Suckers made their appearance in measure as the water receded. It is interesting that they tended to enter central lake areas during their spawning period.

Soft shell turtles appeared with warm weather. A significant correlation with temperature existed: r, .691; df 11.

Longnose gar, one of the major non-game species in Lake Panasoffkee, became scarcer with increasing temperatures: the significant coefficient of correlation was —.658; df 11. They were present in greatest numbers in December and January and decreased in abundance prior to, and through the spawning period.

The speckled bullhead was more numerous in warm weather; the coefficient of correlation with temperature, r, .616; df 11, is statistically significant. They probably spent the winter buried in silt and mud.

No significant correlation could be drawn between temperature or water level and numbers of gizzard shad (the species of greatest numerical abundance), however several pertinent facts must be mentioned. There were sharp decreases in numbers in December and February with immediately following recoveries during the months of January, March and April. In May another very marked diminishing occurred which was followed by no subsequent recovery. The shad had finished spawning in May. Length-frequency measurements (Table 14) disclosed an absence of shad of 15.5 inches and longer during June and July, a gradual reappearance of a few 15.5 and 16.0 fish in August, of 16.5 and 17.0 inch fish in September, and of 17.5 inch fish in October. Frederick Berry (unpublished M.S. Thesis, University of Florida, 1955) demonstrated that a massed mortality of gizzard shad occurs in Newnan's Lake

near Gainesville, Florida toward the end of its spawning season in April or May. A similar massed spawning mortality apparently took place in Lake Panasoffkee beginning in May 1954.

Relationships between numbers of shellcracker and bluegill (the gamefishes of major incidence) with temperature and other factors were not clear. The data however suggest these species were susceptible of movements and subject to massed mortalities analogous to the gizzard shad.

Black crappie was a minor game fish in Lake Panasoffkee. It composed less than 2% of the total populations. Ecological factors responsible for its scarcity are obscure.

Bass constituted more than 3 percent of the total numbers of fishes. The majority taken in the haul seine were small: total length 10.5 to 11.5 inches; progression in size by growth was hardly perceptible from length-frequency data. As with the crappie, relationships between their abundance and ecological factors were undetermined.

Periodic fluctuations in abundance of fishes in Lake Panasoffkee were due, therefore, to growth, to spawning mortalities, and to movements into and out of the main lake areas for purposes of feeding, spawning and other seasonal activities.

The Sport Catch

Six thousand creel census checks were made of fishermen who had fished 13,000 hours and caught more than 18,000 gamefishes during the 18-month period. Most of the fishing effort had been directed toward bream, about one-third to catching bass, and only a small fraction of the total effort was expended on crappie (Tables 34-37). Approximately 86 percent of the fish caught were bream; 11 percent, bass; and less than 3 percent of the total catch consisted of crappie.

Statistically significant correlations existed between average catch per fisherman and average time spent. Correlation coefficients for bass and bream were respectively .805 and .817, df 16.

Periods of increased yield suggest corresponding periods of heightened specific vulnerability. Most of the bream were caught in the warm seasons, nearly all the crappie during the cool months, and data from tagged bass returns from both the Withlacoochee-Panasoffkee and the St. Johns areas hint at accelerated catch during the winter and spring. One of the weaknesses of the treatment

lies in its inability to deny or confirm the existence of recurrent periods of good fishing success.

From the data, it would appear that during the time period March 1954 to August 1955 the average fisherman on Panasoffkee caught 0.6 bass, 1.0 crappie or 1.7 bream per hour of fishing. The duration of his average fishing trip appeared to be 4 hours for bass, 3.8 hours for crappie, or 4 hours for bream.

Total yield and pressure on the areas are not reported. The necessary projection involved is susceptible of great error. Total yield however was slight, while pressure at times was high.

Conclusions

Populations of rough fishes were not significantly affected by, nor did noticeable improvement in sportfishing success result from non-gamefish removal by haul seine. Fishes traveled, sometimes over long distances, between the Lake, sloughs and streams, and the River. A gradual decline in total fish populations appeared to be directly related to a steady recession in water level. Sharply reduced numbers of gizzard shad in mid-spring were apparently the result of a massed spawning mortality. Proportions of gamefishes taken by sportfishing methods were roughly equivalent to proportions taken by haul seine. Most of the fishing effort was directed toward catching bream, which also constituted the bulk of the sport catch. The average fisherman caught 0.6 bass, 1.0 crappie, or 1.7 bream per hour of effort. The length of his average fishing trip was about 4 hours.

Summary

A Federal-Aid fisheries investigation of Lake Panasoffkee and the nearby Withlacoochee River areas during the period 1951 to 1956 consisted of water quality analysis and ecological studies, creel census, sampling and tagging of the major fish populations, and an inquiry into the effects of non-gamefish removal by Florida haul seine on total populations and on sport catch.

Lake Panasoffkee has an area of about 7 square miles, is shallow, and is long and narrow in shape. It is spring-fed and flows into Withlacoochee River. Panasoffkee waters were fresh and markedly alkaline in character. Phytoplanktal coloring was pronounced, dense beds of *Vallisneria* were present, and it supported high populations of fresh water fishes. The waters of the north-flowing With-

lacoochee River were neutral to slightly acid in nature, were deeply stained from decaying plant material, and produced fewer fishes per unit area than Lake Panasoffkee.

Fishes spawned in Lake Panasoffkee from January through October. Massed movements of fishes became apparent in winter and early spring. Journeyings occurred between deep and shallow areas of the lake, between the lake and the river, and between creeks, sloughs, the lake and the river. A significant statistical correlation was evident between temperature and numbers of longnose gar taken in the seining areas. The gar became scarcer with increasing temperatures. This phenomenon was evidently associated with their spawning habits. The occurrence frequency of speckled bullhead evinced a positive correlation with temperature. A massed mortality of gizzard shad occurred toward the close of its spawning season in May.

A gradual decline in total fish populations appeared to be directly related to a steady recession of water level. The incidence of golden shiner was directly, while that of the chub sucker was inversely correlated with water level.

During the 13 month period October 1953 to October 1954 a total of 153 seine hauls took approximately 300,000 pounds of fishes, 200,000 pounds of which were non-game fishes. The area covered by the average seine haul was about 40 acres, the average number of hauls per month was 12, and recruitment of smaller size groups into the range of net selectivity was rapid. More gizzard shad and garfishes were taken during the last month of operation than in the month seining began.

Six thousand creel census checks were made in the 18-month period March 1954 to August 1955. In 13,000 hours sports fishermen had caught more than 18,000 gamefishes, 86 percent of which were bream, 11 percent bass, and less than 3 percent crappie. Comparative percentages of gamefishes taken by haul seine are as follows: bream 78 percent, bass 15 percent, and crappie 7 percent. Most of the fishing effort had been directed to catching bream, about one-third of it towards bass, and a much smaller amount of effort toward crappie. The latter species was a gamefish of minor abundance in Lake Panasoffkee. Statistically significant correlations were found between average catch per fisherman and average time spent. The average fisherman caught 0.6 bass, 1.0 crappie or 1.7 bream per hour of fishing effort. The length of his average fishing trip was about 4 hours.

List of Species Taken

Fishes:

Mudfish—*Amia calva* Linnaeus
Longnose Gar—*Lepisosteus osseus* (Linnaeus)
Florida Spotted Gar—*Lepisosteus platyrhinchus* DeKay
Gizzard Shad—*Dorosoma cepedianum* (LeSueur)
Eastern, or Lake, Chub Sucker—*Erymyzon sucetta sucetta* (Lacépède)
Golden Shiner—*Notemigonus crysoleucas bosci* (Cuvier and Valenciennes)
Channel Catfish—*Ictalurus punctatus* (Rafinesque)
White Catfish—*Ictalurus catus* (Linnaeus)
Speckled Bullhead—*Ameiurus nebulosus marmoratus* (Holbrook)
Yellow Bullhead—*Ameiurus natalis* Jordan
Chain Pickerel—*Esox niger* LeSueur
Warmouth—*Chaenobryttus coronarius* (Bartram)
Shellcracker—*Lepomis microlophus* (Gunther)
Bluegill—*Lepomis macrochirus purpurescens* Cope
Redbreast—*Lepomis auritus* (Linnaeus)
Stumpknocker—*Lepomis punctatus punctatus* (Valenciennes)
Black Crappie—*Pomoxis nigromaculatus* (LeSueur)
Black Bass—*Micropterus salmiodes floridanus* (LeSueur)

Turtles:

Southeastern Soft Shell—*Amyda ferox* (Schneider)
Terrapins, or Cooters—*Pseudemys* spp.

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TABLE 1

Chemical and Physical Observation of Water Quality

Month	Date	Time	Water Temperature °F	D.O.	CO_2	pH	Color
October 1953	22	12:40 P.M.	74	—	2.0	8.5	Coffee
	27	10:45 A.M.	74	—	5.0	8.0	to Tea
November	4	10:00 A.M.	70	7.7	3.0	8.0	Tea
	16	10:30 A.M.	65	8.0	4.0	7.7	
	30	12:10 P.M.	64	9.4	0.0	8.5	
December	3	10:15 A.M.	62	8.4	0.0	8.3	Light
	16	11:10 A.M.	59	8.1	0.0	8.7	Green
	29	10:45 A.M.	60	—	3.0	7.6	
January 1954	27	8:55 A.M.	—	6.0	1.0	7.8	Green Color Faded
February	3	10:10 A.M.	60	7.0	0.0	8.3	Tea
	15	11:30 A.M.	64	9.0	0.0	8.5	
March	8	12:10 P.M.	56	7.9	0.0	8.2	Light
	25	9:45 A.M.	72	7.0	0.0	—	Green
April	2	9:05 A.M.	76	7.0	0.0	8.0	Light
	15	11:30 A.M.	84	6.2	0.0	8.5	Green
May	12	9:55 A.M.	82	7.4	0.0	8.6	Deep
	26	9:45 A.M.	75	—	0.0	8.5	Green
June	7	11:15 A.M.	86	7.6	0.0	8.3	Faded Green
July	1	9:45 A.M.	87	6.0	0.0	8.3	Faded
	28	9:15 A.M.	82	5.6	0.0	8.0	Deep Green
August	2	8:50 A.M.	86	7.0	0.0	8.5	Fading
	17	9:25 A.M.	90	6.9	0.0	8.6	Deep Green
September	8	9:55 A.M.	84	5.9	0.0	8.5	Deep Sea
	29	11:00 A.M.	83	6.6	0.0	8.5	Green
October	12	11:00 A.M.	78	8.4	0.0	8.5	
	19	10:15 A.M.	68	9.4	0.0	8.3	
September 1955 (Outlet Reversal Phenomenon)	28	4:30 P.M.	86	10.2	0.0	9.5	Light Tea
	Note: On this date; Bicarbonates = 23 ppm; Carbonates = 28 ppm; Total M.O. Alkalinity = 51 ppm						
February 1957	2	4:00 P.M.	77	8.4	0.0	8.5	
	Note: On this date; Cl— = 3 ppm; Bicarbonate (HCO_3) = 103 ppm; Carbonate (CO_3) = 16 ppm; Sulfates (SO_4) = 51 ppm; Total M.O. Alkalinity = 119 ppm						
WITHLACOOCHEE RIVER							
April 1954	27	11:00 A.M.	78	3.8	8.0	7.5	Coffee
September 1955	28	3:00 P.M.	84	1.2	18.4	6.5	Dark Coffee
	Note: Bicarbonates (HCO_3) = 26 ppm						

TABLE 2

Average Water Levels in Lake Panasoffkee and Mean Monthly Temperatures at Bushnell

(From U. S. Climatological Records)

Month	Temperature °F	Water Level (Feet)*
October 1953	68.6	5.84
November	65.2	4.64
December	62.5	5.04
January 1954	61.8	4.91
February	61.8	4.41
March	63.5	3.99
April	73.8	3.80
May	73.7	3.35
June	80.4	3.11
July	80.9	3.06
August	82.4	3.28
September	80.7	3.38
October	70.7	3.47
November	61.8	—
December	55.2	—
January 1955	57.2	—
February	61.2	—
March	66.8	2.78
April	71.8	2.68 (April 23)
May	77.2	—
June	77.8	—
July	80.2	—
August	81.9	2.58

* Zero of gage not determined.

TABLE 3

SPAWNING OBSERVATIONS

Month	Gonad Condition — Numbers Fish Observed				
	Immature	Developing	Near Ripe	Ripe	Spent
Bass					
January 1954	Many fish seen in shallow water				
March	Numerous fish seen bedding				
April	5	4	—	4	4
May	1	1	—	—	—
September	—	—	—	—	1
October	—	3	1	—	—
Bluegill					
April	12	57	12	20	4
July	Many fish observed on beds				
August	Many fish observed on beds				
September	—	1	—	1	—
October	—	5	2	—	2
Shellcracker					
March	Seen fanning beds				
April	—	6	—	3	2
May	Most fish in spawning condition				
August	—	—	—	1	—
September	—	1	—	—	2
October	—	3	9	—	12
Longnose Gar					
December 1953	—	—	2	—	—
February 1954	—	—	1	—	—
March	Concentrations observed in adjoining creeks			4	
April	—	4	6	71	—
May	—	—	8	18	3
June	—	1	—	4	7
July	No observations made				
August	—	6	—	1	—
September	—	10	—	—	—
October	—	17	28	—	—

TABLE 3
(Continued)

SPAWNING OBSERVATIONS

Month	Gonad Condition — Numbers Fish Observed				
	Immature	Developing	Near Ripe	Ripe	Spent
			Florida Gar		
March 1954	Several seen partly buried in mud and silt in 2′ water depth				
April	—	—	1	8	—
May	—	—	—	6	—
June	—	—	—	1	—
August	Many seen on bream beds				
September	—	—	—	—	1
October	—	1	4	2	2
			Gizzard Shad		
January 1954	Gonads in ripening condition, near end of month				
February	Many fish seen at edges of shore				
March	15	—	31	120	35
April	8	43	2	56	73
May	—	31	—	—	19
October	—	61	—	—	—
			Speckled Bullhead		
February	Gonads well developed				
March	—	—	—	—	1
May	—	—	—	1	—
			Lake Chub Sucker		
April	—	—	1	—	65
September	—	—	—	—	1
October	—	11	3	8	—
			Stumpknocker		
April	—	—	—	1	—
			Warmouth		
April	—	—	—	1	—

TABLE 4

LAKE PANASOFFKEE

TOTAL HAUL SEINE CATCH

October 19, 1953-October 26, 1954
(153 Hauls)

Fish Taken	Pounds	Composition By Percent	Numbers	Composition By Percent
Bass	11,737	3.9	12,457	3.3
Crappie	4,630	1.5	5,661	1.5
Bluegill	20,884	6.9	58,645	15.6
Shellcracker	49,817	16.5	86,399	23.0
Redbreast	53	—	228	—
Chain Pickerel	173	0.1	42	—
Channel Cat	323	0.1	21	—
White Catfish	213	0.1	120	—
Speckled Bullhead	3,956	1.3	1,897	0.5
Longnose Gar	49,929	16.5	7,851	2.1
Florida Gar	347	0.1	215	—
Mudfish	10	—	4	—
Gizzard Shad	157,283	52.1	199,512	53.0
Chub Sucker	2,052	0.7	1,729	0.5
Golden Shiner	472	0.2	1,469	0.4
Total Fish	301,878	100.0	376,250	99.9
Total Fish Removed	214,585	71.1	212,812	56.6
Soft-shell Turtle	732	0.2	68	—
Terrapin	13,595	4.3	2,285	0.3

TABLE 5

Average Pounds Taken Per Acre of Haul Area Covered, and Calculated Total Pounds Fishes Available to the Net at a Given Moment of Time

	All Fishes	Non-Game Fishes
Average Pounds Taken Per Acre Per Haul:	45.96	33.88 (Removed)
Calculated Total Pounds Available In Lake at a Given Moment of Time:	215,323	158,728
Total Pounds Taken During The 13 Month Period:	301,878	214,585 (Removed)

Calculations Based on Total Lake Area of 4,685 Acres (Moody 1954).

TABLE 6

Monthly Haul Seine Summary
Lake Panasoffkee
Total Catch: (Pounds)

Month Year No. of Hauls	Oct. 1953 8	Nov. 1953 9	Dec. 1953 12	Jan. 1954 7	Feb. 1954 14	March 1954 15	April 1954 19	May 1954 14	June 1954 6	July 1954 10	Aug. 1954 17	Sept. 1954 8	Oct. 1954 14
Species													
Largemouth Bass	817	1,286	1,227	314	728	719	1,453	695	375	943	1,281	620	1,280
Black Crappie	1,404	486	398	180	123	209	257	416	101	220	314	131	392
Bluegill	648	1,773	1,874	1,388	1,194	1,724	6,851	1,131	195	1,397	1,734	221	754
Shellcracker	1,169	2,765	4,227	2,894	3,032	2,735	10,604	4,119	1,008	3,315	9,071	1,449	3,430
Redbreast	—	36	13	—	3	—	—	—	—	—	—	—	—
Chain Pickerel	69	25	44	—	14	6	3	—	—	—	—	1	11
Channel Catfish	—	37	74	50	67	—	27	—	—	—	33	14	21
White Catfish	5	6	62	3	24	10	27	18	16	14	15	2	11
Speckled Bullhead	26	113	74	153	68	36	906	610	243	452	574	332	371
Longnose Gar	1,511	5,462	7,587	4,444	4,341	3,042	6,877	4,041	1,094	4,085	2,887	1,037	3,522
Other Gar	12	29	56	7	34	48	24	20	12	21	16	8	59
Mudfish	2	5	—	—	4	—	—	—	—	—	—	—	—
Gizzard Shad	6,702	11,057	9,102	17,830	8,638	14,083	30,504	10,088	3,578	9,057	14,777	5,723	16,144
Chub Sucker	12	7	—	—	—	2	300	766	93	136	250	76	410
Golden Shiner	271	114	20	—	53	2	—	—	—	—	—	—	12
Total Fish	12,648	23,201	24,758	27,263	18,323	22,616	57,832	21,904	6,715	19,640	30,952	9,615	26,417
Removed	8,539	16,830	16,975	22,487	13,229	17,223	38,664	15,544	5,036	13,765	18,552	7,193	20,551
Soft-shell Turtle	12	18	—	—	—	—	91	88	51	32	328	36	76
Terrapin	215	611	1,032	285	483	1,198	2,163	955	380	936	1,729	1,029	2,479

TABLE 7

Locations of Tagging and Recapture of Fishes Tagged
October 1953-February 1955

	Bass	Crappie	Bluegill	Shell-cracker	Gizzard Shad
Fish Tagged in Lake:	378	62	448	536	30
Caught: Lake	81	3	2	9	1
River	3	—	—	—	—
Outlet	2	—	—	—	—
Creeks and Sloughs	17	—	2	—	—
Fish Tagged in River:	14	—	24	53	1
Caught: Lake	—	—	—	—	—
River	5	—	—	2	—
Outlet	—	—	—	—	—
Creeks and Sloughs	—	—	—	—	—
Fish Tagged in Outlet:	44	3	11	4	—
Caught: Lake	—	—	—	—	—
River	—	—	—	—	—
Outlet	1	—	—	—	—
Creeks and Sloughs	—	—	—	—	—
Fish Tagged in Creeks and Sloughs	3	13	33	18	—
Caught: Lake	—	—	1	—	—
River	—	—	—	—	—
Outlet	—	—	1	—	—
Creeks and Sloughs	—	—	6	—	—
Total Number Tagged	439	88	516	611	31
Retaken by Sportsmen	29	—	3	7	—
Found Dead	2	—	—	1	—
Retaken by Net and Traps	78	3	9	3	1

TABLE 7 — Continued

Locations of Tagging and Recapture of Fishes Tagged
October 1953-February 1955

	Speckled Bullhead	Yellow Bullhead	Stumpknocker	Warmouth
Fish Tagged in Lake	2	—	—	—
Caught: Lake	—	—	—	—
River	—	—	—	—
Outlet	—	—	—	—
Creeks and Sloughs	—	—	—	—
Fish Tagged in River	1	—	8	4
Caught: Lake	—	—	—	—
River	—	—	—	—
Outlet	—	—	—	—
Creeks and Sloughs	—	—	—	—
Fish Tagged in Outlet	2	—	3	6
Caught: Lake	—	—	—	—
River	—	—	—	—
Outlet	—	—	—	—
Creeks and Sloughs	—	—	—	—
Fish Tagged in Creeks and Sloughs	28	8	88	106
Caught: Lake	—	—	1	4
River	—	—	—	—
Outlet	—	—	—	—
Creeks and Sloughs	1	1	1	3
Total Number Tagged	33	8	99	116
Retaken by Sportsmen	1	—	1	1
Found Dead	—	—	—	—
Retaken by Nets and Traps	—	1	1	6

TABLE 8

Haul Seine
Average Pounds Per Haul Comparison
Lake Panasoffkee

Date	April 6-May 2, 1951	Oct. 19, 1953-Oct. 26, 1954
No. Hauls	13	153
Length and Minimum Mesh of Net:	835 Yards, 3″ Stretched Mesh	1,000 Yards, 3″ Stretched Mesh
Bass	109	77
Crappie	82	30
Bluegill	185	137
Shellcracker	559	326
Redbreast	—	—
Chain Pickerel	—	1
Channel Catfish	9	2
White Catfish	1	1
Speckled Bullhead	126	26
Longnose Gar	1,202	326
Florida Gar	97	2
Mudfish	2	—
Gizzard Shad	1,051	1,028
Chub Sucker	14	13
Golden Shiner	—	3
Total Fish	3,437	1,646
Soft-shell Turtle	4	5
Terrapin	800	889

TABLE 9

Comparison of Average Total Lengths of Fish Taken by Haul Seine in 1951 and 1954 in Lake Panasoffkee

	Average Length, Inches	
	April 1951	April 1954
Bass	12.8	12.1
Crappie	12.8	12.1
Bluegill	8.4	6.9
Shellcracker	10.4	8.5
Gizzard Shad	12.6	12.3

TABLE 10

Length-frequency of Largemouth Bass Taken in the Haul Seine, Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	Oct. 1953 No.	Oct. 1953 %	Nov. 1953 No.	Nov. 1953 %	Dec. 1953 No.	Dec. 1953 %	Jan. 1954 No.	Jan. 1954 %	Feb. 1954 No.	Feb. 1954 %	Mar. 1954 No.	Mar. 1954 %	Apr. 1954 No.	Apr. 1954 %
7.0	......	......	......	......	......	......	......	......	......	......	......	......	......	......
7.5	......	......	......	......	......	......	......	......	......	......	......	......	......	......
8.5	......	......	......	......	......	......	......	......	......	......	......	......	......	......
9.0	......	......	2	2	......	......	......	......	......	......	......	......	3	......
9.5	1	2	2	2	4	2	......	......	2	1	6	1	11	2
10.0	6	12	11	11	12	5	2	2	5	1	21	5	41	6
10.5	8	15	22	22	34	13	6	7	63	16	68	15	131	19
11.0	11	20	25	25	74	28	18	21	90	23	140	30	166	24
11.5	5	9	9	9	59	23	20	23	89	23	93	20	126	19
12.0	5	9	12	12	25	10	15	17	57	15	34	7	90	13
12.5	5	9	3	3	12	5	4	5	22	6	20	4	21	3
13.0	2	4	2	2	4	2	4	5	13	3	13	3	13	2
13.5	......	......	1	1	5	2	2	2	2	1	4	1	4	1
14.0	2	4	......	......	2	1	......	......	2	1	5	1	4	1
14.5	1	2	......	......	1	......	......	......	2	1	4	1	3	......
15.0	1	2	......	......	1	......	1	1	......	......	3	1	2	......
15.5	......	......	......	......	......	......	1	1	1	......	3	1	2	......
16.0	1	2	......	......	......	......	......	......	1	......	2	......	......	......
16.5	2	4	......	......	......	......	......	......	1	......	2	......	2	......
17.0	......	......	......	......	......	......	......	......	......	......	1	......	......	......
17.5	......	......	......	......	......	......	1	1	......	......	1	......	2	......
18.0	......	......	......	......	......	......	......	......	......	......	1	......	4	1
18.5	......	......	......	......	1	......	......	......	2	1	......	......	3	......
19.0	......	......	3	3	1	......	1	1	2	1	4	1	3	......
19.5	1	2	......	......	2	1	1	1	2	1	3	1	6	1
20.0	1	2	......	......	4	2	3	3	6	2	5	1	6	1
20.5	1	2	......	......	2	1	2	2	7	2	4	1	5	1
21.0	......	......	1	1	7	3	3	3	4	1	9	2	16	2
21.5	......	......	3	3	4	2	2	2	4	1	4	1	5	1
22.0	1	2	......	......	1	......	......	......	1	......	3	1	4	1
22.5	......	......	1	1	2	1	1	1	2	1	1	......	4	1
23.0	......	......	2	2	2	1	......	......	2	1	4	1	1	......
23.5	......	......	......	......	......	......	......	......	......	......	......	......	2	......
24.0	......	......	1	1	......	......	......	......	2	1	......	......	2	......
24.5	......	......	1	1	1	......	......	......	......	......	......	......	......	......
25.0	......	......	......	......	1	......	......	......	1	......	2	......	......	......
25.5	......	......	......	......	......	......	......	......	1	......	......	......	......	......
Totals	54	......	101	......	261	......	87	......	386	......	460	......	682	......
Av. Length	12.4		12.2		12.4		13.1		12.3		12.2		12.1	

TABLE 10—Continued

Length-frequency of Largemouth Bass Taken in the Haul Seine, Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	May 1954		June 1954		July 1954		Aug. 1954		Sept. 1954		Oct. 1954		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
7.0	......	......	......	......	......	......	......	......	......	......	......	......	......	......
7.5	......	......	......	......	......	......	......	......	1	......	......	......	1	......
8.5	......	......	1	1	......	......	1	......	......	......	......	......	2	......
9.0	1	......	......	......	......	......	2	......	......	......	5	1	13	......
9.5	3	1	2	2	5	2	5	1	8	3	31	4	80	2
10.0	27	7	12	10	17	6	38	5	18	6	63	9	273	6
10.5	45	12	13	11	37	13	111	15	32	11	87	12	657	14
11.0	113	29	34	28	95	33	225	30	70	24	200	28	1261	27
11.5	108	28	28	23	69	24	194	26	96	33	170	24	1066	23
12.0	39	10	13	11	31	11	93	12	30	10	105	15	549	12
12.5	13	3	2	2	3	1	31	4	15	5	22	3	173	4
13.0	5	1	......	......	2	1	2	......	2	1	6	1	68	2
13.5	3	1	1	1	1	......	5	1	3	1	......	......	31	1
14.0	1	......	......	......	1	......	1	......	2	1	1	......	21	1
14.5	......	......	1	1	......	......	1	......	2	1	......	......	15	......
15.0	3	1	......	......	1	......	3	......	1	......	......	......	16	......
15.5	......	......	......	......	......	......	2	......	......	......	1	......	10	......
16.0	......	......	......	......	......	......	2	......	......	......	......	......	6	......
16.5	1	......	1	1	......	......	......	......	1	......	1	......	11	......
17.0	1	......	......	......	......	......	1	......	......	......	1	......	4	......
17.5	2	1	......	......	1	......	1	......	......	......	3	......	11	......
18.0	......	......	......	......	1	......	2	......	......	......	1	......	9	......
18.5	2	1	1	1	......	......	2	......	......	......	1	......	12	......
19.0	......	......	......	......	5	2	2	......	......	......	1	......	22	1
19.5	3	1	1	1	5	2	......	......	......	......	1	......	25	1
20.0	......	......	......	......	1	......	4	1	......	......	3	......	33	1
20.5	2	1	......	......	2	1	1	......	2	1	3	......	31	1
21.0	10	3	2	2	......	......	7	1	2	1	3	......	64	1
21.5	4	1	5	4	5	2	4	1	1	......	1	......	42	1
22.0	2	1	2	2	1	......	5	1	2	1	3	......	25	1
22.5	1	......	......	......	2	1	1	......	1	......	5	1	21	1
23.0	2	1	......	......	3	1	2	......	3	1	2	......	23	1
23.5	......	......	1	1	......	......	2	......	1	......	......	......	6	......
24.0	......	......	......	......	......	......	1	......	......	......	......	......	6	......
24.5	......	......	......	......	......	......	1	......	......	......	......	......	3	......
25.0	......	......	......	......	......	......	......	......	......	......	......	......	4	......
25.5	......	......	......	......	......	......	......	......	......	......	......	......	1	......
Totals	391	......	120	......	288	......	752	......	293	......	720	......	4595	......
Av. Length	12.0		12.2		12.0		11.7		11.7		11.5		9.2	

TABLE 11

Length-frequency of Black Crappie Taken in the Haul Seine, Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	Oct. 1953		Nov. 1953		Dec. 1953		Jan. 1954		Feb. 1954		Mar. 1954		Apr. 1954	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
7.5	------	------	------	------	------	------	------	------	------	------	------	------	------	------
8.0	------	------	------	------	------	------	------	------	------	------	------	------	1	1
8.5	------	------	------	------	------	------	------	------	------	------	------	------	2	2
9.0	------	------	------	------	------	------	------	------	------	------	1	1	1	1
9.5	------	------	------	------	------	------	------	------	------	------	------	------	------	------
10.0	------	------	1	4	1	3	4	10	5	6	------	------	4	3
10.5	------	------	2	7	------	------	------	------	8	10	2	1	10	8
11.0	1	20	6	22	5	14	3	8	7	9	9	6	16	13
11.5	------	------	1	4	4	11	4	10	7	9	11	7	10	8
12.0	1	20	2	7	6	17	9	23	10	13	32	20	36	28
12.5	1	20	6	22	11	31	7	18	13	16	35	22	16	13
13.0	------	------	5	19	3	8	1	3	8	10	13	8	8	6
13.5	------	------	1	4	------	------	3	8	2	3	16	10	4	3
14.0	------	------	1	4	1	3	1	3	8	10	18	11	8	6
14.5	1	20	1	4	2	6	4	10	11	14	18	11	9	7
15.0	1	20	1	4	3	8	2	5	1	1	4	3	3	2
15.5	------	------	------	------	------	------	1	3	------	------	1	1	------	------
Totals	5	------	27	------	36	------	39	------	80	------	160	------	128	------
Av. Length	13.0		12.2		12.4		12.4		12.4		12.8		12.1	

TABLE 11—Continued

Length-frenquency of Black Crappie Taken in the Haul Seine, Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	May 1954		June 1954		July 1954		Aug. 1954		Sept. 1954		Oct. 1954		Total 1953-1954	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
7.5	1	......	1	1	1	1	......	......	......	......	2	......	5	......
8.0	6	1	3	3	7	4	3	1	......	......	......	......	20	1
8.5	14	3	17	18	22	11	31	7	5	2	15	3	106	4
9.0	21	5	11	12	30	16	96	21	40	20	73	13	273	11
9.5	3	1	11	12	21	11	69	15	52	25	146	26	302	13
10.0	11	3	3	3	4	2	33	7	11	5	90	16	167	7
10.5	26	6	7	7	12	6	27	6	7	3	35	6	136	6
11.0	53	12	12	13	10	5	48	11	20	10	53	9	243	10
11.5	55	13	5	5	16	8	33	7	14	7	52	9	212	9
12.0	76	18	3	3	13	7	25	6	20	10	40	7	273	11
12.5	77	18	10	10	28	14	37	8	17	8	25	4	283	12
13.0	29	7	5	5	8	4	10	2	7	3	17	3	114	5
13.5	8	2	1	1	4	2	7	2	5	2	1	......	52	2
14.0	25	6	4	4	8	4	16	4	4	2	12	2	106	4
14.5	16	4	2	2	7	4	12	3	3	2	3	1	89	4
15.0	7	2	1	1	3	2	1	......	......	......	......	......	27	1
15.5	......	......	......	......	......	......	......	......	......	......	......	......	2	......
Totals	428	......	96	......	194	......	448	......	205	......	564	......	2,410	......
Av. Lengths	11.8		10.5		10.8		10.6		10.6		10.4		11.1	

TABLE 12

Length-frequency of the Bluegill Taken in the Haul Seine, Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	Oct. 1953 No.	Oct. 1953 %	Nov. 1953 No.	Nov. 1953 %	Dec. 1953 No.	Dec. 1953 %	Jan. 1954 No.	Jan. 1954 %	Feb. 1954 No.	Feb. 1954 %	Mar. 1954 No.	Mar. 1954 %
5.0	------	------	------	------	------	------	------	------	------	------	------	------
5.5	------	------	------	------	------	------	------	------	------	------	2	------
6.0	------	------	3	3	1	1	1	------	------	------	9	1
6.5	2	5	14	14	6	5	10	5	6	1	50	6
7.0	9	24	34	33	15	13	29	13	40	9	137	17
7.5	12	32	34	33	33	28	62	28	106	25	199	24
8.0	13	35	13	13	44	38	94	42	211	49	253	31
8.5	1	3	4	4	13	11	24	11	51	12	125	15
9.0	------	------	------	------	3	3	2	1	12	3	29	4
9.5	------	------	------	------	1	1	------	------	------	------	4	1
10.0	------	------	------	------	------	------	2	1	------	------	4	1
10.5	------	------	------	------	------	------	------	------	1	------	3	------
Totals	37	------	102	------	116	------	224	------	427	------	815	------
Av. Length	7.5		7.3		7.7		7.7		7.9		7.7	

TABLE 12—Continued

Length-frequency of the Bluegill Taken in the Haul Seine, Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	April 1954 No.	April 1954 %	May 1954 No.	May 1954 %	Aug. 1954 No.	Aug. 1954 %	Sept. 1954 No.	Sept. 1954 %	Oct. 1954 No.	Oct. 1954 %	Total 1953-1954 No.	Total 1953-1954 %
5.0	5	1	1	1	......	......	......	......	......	......	6	......
5.5	33	6	15	9	1	1	3	4	3	1	57	2
6.0	68	13	17	10	8	8	10	14	32	10	149	5
6.5	120	23	21	12	10	10	12	17	46	15	297	10
7.0	114	22	29	17	18	17	12	17	71	23	508	18
7.5	111	21	46	27	25	24	16	22	95	30	739	25
8.0	58	11	29	17	24	23	9	13	51	16	799	28
8.5	13	3	11	6	15	14	7	10	16	5	280	10
9.0	2	......	2	1	2	2	2	3	......	......	54	2
9.5	......	......	......	......	2	2	......	......	......	......	7	......
10.0	......	......	......	......	......	......	1	1	......	......	7	......
10.5	......	......	......	......	......	......	......	......	......	......	4	......
Totals	524	......	171	......	105	......	72	......	314		2,907	......
Av. Length	6.9		7.1		7.5		7.2		7.2		7.5	

TABLE 13

Length-frequency of the Shellcracker Taken in the Haul Seine From Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	Oct. 1953		Nov. 1953		Dec. 1953		Jan. 1954		Feb. 1954		Mar. 1954		Apr. 1954	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
5.5	......	......	......	......	......	......	......	......	......	......	......	......	......	......
6.0	......	......	......	......	2	......	......	......	......	......	1	......	2	1
6.5	1	1	14	4	20	5	2	1	2	......	3	......	1	1
7.0	2	3	50	14	58	13	10	3	8	1	27	3	12	7
7.5	13	17	88	24	76	17	25	7	53	7	106	10	20	12
8.0	25	33	87	24	125	28	111	29	179	24	233	23	35	20
8.5	13	17	46	13	86	19	104	27	181	24	233	23	41	24
9.0	4	5	25	7	26	6	54	14	137	18	181	18	23	13
9.5	5	7	17	5	13	3	30	8	68	9	98	10	14	8
10.0	5	7	12	3	17	4	26	7	50	7	55	5	10	6
10.5	4	5	13	4	15	3	13	3	51	7	29	3	4	2
11.0	3	4	7	2	4	1	5	1	16	2	30	3	5	3
11.5	......	......	1	......	1	......	2	1	2	......	11	1	2	1
12.0	......	......	1	......	3	1	2	1	1	......	5	1	1	1
12.5	......	......	......	......	......	......	......	......	1	......	4	......	2	1
13.0	......	......	......	......	......	......	1	......	......	......	3	......	......	......
13.5	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Totals	75	......	361	......	446	......	385	......	749	......	1,019	......	172	......
Av. Length	8.5		8.1		8.1		8.6		8.8		8.7		8.6	

TABLE 13—Continued

Length-frequency of the Shellcracker Taken in Haul Seine From Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	May 1954 No.	May 1954 %	July 1954 No.	July 1954 %	Aug. 1954 No.	Aug. 1954 %	Sept. 1954 No.	Sept. 1954 %	Oct. 1954 No.	Oct. 1954 %	Total 1953-1954 No.	Total 1953-1954 %
5.5	......	......	......	......	......	......	1	......	......	......	1	......
6.0	8	1	1	1	8	2	4	2	2	1	28	1
6.5	15	2	3	4	14	4	12	7	7	2	94	2
7.0	38	5	7	9	39	10	5	3	24	7	280	6
7.5	64	8	6	8	47	12	11	6	37	10	546	11
8.0	186	23	17	22	78	20	19	11	65	18	1,160	23
8.5	168	21	20	25	80	21	43	24	78	22	1,093	22
9.0	114	14	12	15	47	12	50	28	69	19	742	15
9.5	52	7	4	5	19	5	14	8	55	15	389	8
10.0	32	4	4	5	18	5	7	4	11	3	247	5
10.5	22	3	1	1	9	2	5	3	2	1	168	3
11.0	16	2	......	......	4	1	5	3	2	1	97	2
11.5	28	4	1	1	8	2	2	1	2	1	60	1
12.0	30	4	......	......	8	2	2	1	5	1	58	1
12.5	20	3	1	1	6	2	......	......	1	......	35	1
13.0	6	1	2	3	......	......	......	......	1	......	13	......
13.5	1	......	......	......	......	......	......	......	......	......	1	......
Totals	800	......	79	......	385	......	180	......	361	......	5,012	......
Av. Length	8.8		8.5		8.5		8.6		8.6		8.6	

TABLE 14

Length-frequency Gizzard Shad Taken in Haul Seine
Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	Oct. 1953 No.	Oct. 1953 %	Nov. 1953 No.	Nov. 1953 %	Dec. 1953 No.	Dec. 1953 %	Jan. 1954 No.	Jan. 1954 %	Feb. 1954 No.	Feb. 1954 %	Mar. 1954 No.	Mar. 1954 %	Apr. 1954 No.	Apr. 1954 %
7.5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
8.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
8.5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9.0	1	1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9.5	6	3	-----	-----	-----	-----	-----	-----	-----	-----	1	-----	-----	-----
10.0	11	5	-----	-----	-----	-----	-----	-----	3	1	8	1	1	-----
10.5	18	9	1	1	-----	-----	2	7	12	5	76	11	12	2
11.0	4	2	-----	-----	-----	-----	7	26	39	15	158	23	76	16
11.5	12	6	3	4	-----	-----	4	15	41	16	129	19	97	20
12.0	9	4	6	8	1	1	2	7	28	11	65	10	130	27
12.5	16	8	6	8	7	8	2	7	13	5	33	5	53	11
13.0	24	12	14	18	11	13	4	15	18	7	45	7	28	6
13.5	23	11	12	15	10	12	1	4	29	11	40	6	17	4
14.0	29	14	17	21	21	25	4	15	30	12	58	9	33	7
14.5	17	8	4	5	9	11	1	4	7	3	19	3	20	4
15.0	13	6	5	6	9	11	-----	-----	9	4	13	2	8	2
15.5	10	5	1	1	5	6	-----	-----	12	5	13	2	9	2
16.0	8	4	6	8	6	7	-----	-----	4	2	6	1	2	-----
16.5	1	1	3	4	2	2	-----	-----	7	3	3	-----	2	-----
17.0	3	2	-----	-----	2	2	-----	-----	-----	-----	5	1	1	-----
17.5	1	1	2	3	2	2	-----	-----	2	1	5	1	2	-----
18.0	-----	-----	-----	-----	-----	-----	-----	-----	1	-----	1	-----	-----	-----
18.5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	2	-----	-----	-----
Totals	206	-----	80	-----	85	-----	27	-----	255	-----	680	-----	491	-----
Av. Length	13.1		13.8		14.3		12.2		12.8		12.2		12.3	

TABLE 14—Continued

Length-frequency Gizzard Shad Taken in Haul Seine
Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	May 1954		June 1954		July 1954		Aug. 1954		Sept. 1954		Oct. 1954		Total 1953-1954	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
7.5	......	......	......	......	......	......	......	......	......	......	2	1	2	......
8.0	......	......	......	......	......	......	......	......	......	......	1	......	1	......
8.5	......	......	......	......	......	......	......	......	1	1	4	1	5	......
9.0	......	......	......	......	......	......	......	......	......	......	4	1	5	......
9.5	......	......	......	......	......	......	......	......	......	......	1	......	8	......
10.0	......	......	......	......	......	......	......	......	......	......	1	......	24	1
10.5	......	......	......	......	1	......	......	......	......	......	......	......	122	4
11.0	6	3	4	4	11	4	......	......	......	......	......	......	305	10
11.5	34	14	10	10	76	30	5	2	......	......	1	......	412	13
12.0	54	23	36	37	66	26	36	14	4	3	9	2	446	14
12.5	37	16	18	19	59	23	74	28	14	10	72	20	404	13
13.0	33	14	19	20	25	10	75	28	42	29	96	26	434	14
13.5	31	13	7	7	7	3	38	14	30	21	72	20	317	10
14.0	14	6	2	2	9	4	22	8	22	15	54	15	315	10
14.5	10	4	......	......	2	1	10	4	11	8	22	6	132	4
15.0	5	2	1	1	1	......	3	1	8	6	11	3	86	3
15.5	7	3	......	......	......	......	1	......	......	......	3	1	61	2
16.0	3	1	......	......	......	......	3	1	2	1	2	1	42	1
16.5	......	......	......	......	......	......	......	......	7	5	3	1	28	1
17.0	2	1	......	......	......	......	......	......	3	2	3	1	19	1
17.5	......	......	......	......	......	......	......	......	......	......	2	1	16	1
18.0	2	1	......	......	......	......	......	......	......	......	......	......	4	......
18.5	......	......	......	......	......	......	......	......	......	......	......	......	2	......
Totals	238	......	97	......	257	......	267	......	144	......	363	......	3,190	......
Av. Length	12.8		12.4		12.2		13.0		13.7		13.3		12.7	

TABLE 15

Length-frequency of Speckled Bullhead Taken in the Haul Seine
Lake Panasoffkee, December 1953 Through October 1954

Total Length in Inches	Dec. 1953 No.	Dec. 1953 %	Jan. 1954 No.	Jan. 1954 %	Feb. 1954 No.	Feb. 1954 %	Mar. 1954 No.	Mar. 1954 %	Apr. 1954 No.	Apr. 1954 %	May 1954 No.	May 1954 %
9.5	------	------	------	------	------	------	------	------	1	1	------	------
10.0	------	------	------	------	------	------	------	------	1	1	1	2
10.5	------	------	------	------	------	------	------	------	1	1	------	------
11.0	1	14	------	------	------	------	------	------	2	2	4	7
11.5	------	------	------	------	------	------	------	------	6	6	1	2
12.0	------	------	------	------	------	------	------	------	5	5	3	5
12.5	1	14	------	------	------	------	------	------	6	6	2	3
13.0	1	14	------	------	------	------	1	13	1	1	3	5
13.5	------	------	------	------	------	------	------	------	4	4	3	5
14.0	------	------	1	13	------	------	------	------	4	4	3	5
14.5	------	------	------	------	1	25	------	------	10	9	7	12
15.0	------	------	2	25	------	------	------	------	5	5	11	18
15.5	------	------	2	25	------	------	1	13	8	7	4	7
16.0	1	14	------	------	1	25	------	------	9	8	5	8
16.5	2	29	1	13	------	------	------	------	4	4	------	------
17.0	------	------	1	13	------	------	------	------	2	2	3	5
17.5	------	------	------	------	------	------	1	13	2	2	4	7
18.0	1	14	1	13	------	------	1	13	18	16	1	2
18.5	------	------	------	------	------	------	2	25	13	12	------	------
19.0	------	------	------	------	2	50	------	------	7	6	3	5
19.5	------	------	------	------	------	------	1	13	1	1	2	3
20.0	------	------	------	------	------	------	1	13	------	------	------	------
Totals	7	------	8	------	4	------	8	------	110	------	60	------
Av. Length	14.8		15.8		17.1		17.6		15.6		14.9	

TABLE 15—Continued

Length-frequency of Speckled Bullhead Taken in the Haul Seine
Lake Panasoffkee, December 1953 Through October 1954

Total Length in Inches	June 1954		July 1954		Aug. 1954		Sept. 1954		Oct. 1954		Total 1953-1954	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
9.5	------	------	------	------	------	------	------	------	------	------	1	------
10.0	------	------	------	------	2	1	------	------	------	------	4	1
10.5	------	------	1	1	5	2	1	1	1	1	9	1
11.0	------	------	6	8	11	5	2	2	1	1	27	3
11.5	1	3	7	10	13	6	4	4	4	3	36	5
12.0	------	------	4	6	16	8	5	5	10	6	43	6
12.5	1	3	8	11	18	9	15	13	8	5	59	8
13.0	3	8	4	6	26	13	13	12	27	17	79	10
13.5	------	------	6	8	16	8	10	9	14	9	53	7
14.0	2	5	6	8	10	5	10	9	16	10	52	7
14.5	3	8	6	8	16	8	12	11	17	11	72	9
15.0	4	10	3	4	14	7	10	9	13	8	62	8
15.5	1	3	7	10	20	10	9	8	10	6	62	8
16.0	5	13	4	6	11	5	10	9	10	6	56	7
16.5	2	5	4	6	8	4	1	1	4	3	26	3
17.0	3	8	1	1	8	4	6	5	7	5	31	4
17.5	3	8	------	------	5	2	2	2	5	3	22	3
18.0	6	15	2	3	6	3	1	1	2	1	39	5
18.5	2	5	2	3	2	1	1	1	3	2	25	3
19.0	3	8	------	------	1	1	------	------	3	2	19	2
19.5	------	------	1	1	------	------	------	------	1	1	6	1
20.0	------	------	------	------	------	------	------	------	------	------	1	------
Totals	39	------	72	------	208	------	112	------	156	------	784	------
Av. Length	16.1		13.9		13.9		14.1		14.4		14.6	

TABLE 16

Length-frequency of White Catfish Taken in the Haul Seine
Lake Panasoffkee, December 1953 Through October 1954

Total Length in Inches	Dec. 1953		Jan. 1954		Feb. 1954		Mar. 1954		Apr. 1954	
	No.	%	No.	%	No.	%	No.	%	No.	%
10.5	1	33	------	------	1	9	------	------	------	------
11.0	------	------	------	------	1	9	------	------	1	8
11.5	------	------	------	------	1	9	------	------	1	8
12.0	------	------	------	------	4	36	1	33	4	31
12.5	------	------	------	------	------	------	1	33	1	8
13.0	------	------	1	100	------	------	------	------	3	23
13.5	------	------	------	------	------	------	------	------	1	8
14.0	------	------	------	------	------	------	------	------	2	15
14.5	------	------	------	------	------	------	------	------	------	------
15.0	------	------	------	------	1	9	------	------	------	------
15.5	------	------	------	------	1	9	------	------	------	------
16.0	2	67	------	------	1	9	------	------	------	------
16.5	------	------	------	------	------	------	------	------	------	------
17.0	------	------	------	------	------	------	------	------	------	------
17.5	------	------	------	------	------	------	1	33	------	------
20.0	------	------	------	------	1	9	------	------	------	------
Totals	3	------	1	------	11	------	3	------	13	------
Av. Length	14.2		13.0		13.4		14.0		12.6	

TABLE 16—Continued

Length-frequency of White Catfish Taken in the Haul Seine
Lake Panasoffkee, December 1953 Through October 1954

Total Length in Inches	May 1954		Aug. 1954		Oct. 1954		Total 1953-1954	
	No.	%	No.	%	No.	%	No.	%
10.5	......	......	......	......	......	......	2	4
11.0	......	......	......	......	......	......	2	4
11.5	1	9	......	......	......	......	3	6
12.0	......	......	......	......	......	......	9	17
12.5	4	36	......	......	......	......	6	11
13.0	......	......	1	14	1	20	6	11
13.5	4	36	......	......	......	......	5	9
14.0	......	......	1	14	......	......	3	6
14.5	1	9	1	14	......	......	2	4
15.0	1	9	......	......	......	......	2	4
15.5	......	......	......	......	......	......	1	2
16.0	......	......	......	......	1	20	4	7
16.5	......	......	3	43	1	20	4	7
17.0	......	......	1	14	2	40	3	6
17.5	......	......	......	......	......	......	1	2
20.0	......	......	......	......	......	......	1	2
Totals	11		7	......	5		54	
Av. Length	13.2		15.4		15.9		13.7	

TABLE 17

Length-weight and Length-frequency of Longnose Gar Taken in the Haul Seine Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	Oct. 1953 No.	Oct. 1953 Av. Wt.	Nov. 1953 No.	Nov. 1953 Av. Wt.	Dec. 1953 No.	Dec. 1953 Av. Wt.	Jan. 1954 No.	Jan. 1954 Av. Wt.	Feb. 1954 No.	Feb. 1954 Av. Wt.	Mar. 1954 No.	Mar. 1954 Av. Wt.	Apr. 1954 No.	Apr. 1954 Av. Wt.
25.0	------	------	------	------	------	------	------	------	------	------	------	------	------	------
25.5	------	------	------	------	------	------	------	------	------	------	------	------	2	1.5
26.0	------	------	------	------	------	------	------	------	------	------	------	------	------	------
26.5	------	------	------	------	------	------	------	------	------	------	------	------	4	1.6
27.0	------	------	------	------	------	------	------	------	------	------	------	------	------	------
27.5	------	------	------	------	------	------	------	------	------	------	------	------	1	1.8
28.0	------	------	------	------	------	------	------	------	------	------	------	------	------	------
28.5	------	------	------	------	------	------	------	------	------	------	------	------	------	------
29.0	1	2.2	------	------	------	------	------	------	------	------	------	------	4	2.4
29.5	------	------	------	------	------	------	------	------	------	------	------	------	------	------
30.0	------	------	------	------	------	------	------	------	1	2.7	1	2.9	7	2.7
30.5	1	3.0	------	------	------	------	1	2.5	------	------	1	3.0	7	2.6
31.0	------	------	1	2.9	1	3.3	2	3.1	------	------	------	------	7	3.0
31.5	------	------	2	3.5	------	------	------	------	------	------	------	------	2	3.6
32.0	------	------	3	3.8	------	------	1	3.2	------	------	1	4.3	4	3.0
32.5	------	------	1	3.8	------	------	------	------	------	------	1	3.6	3	3.1
33.0	------	------	2	4.0	------	------	1	3.5	------	------	1	3.5	5	3.2
33.5	------	------	3	3.6	------	------	------	------	------	------	------	------	------	------
34.0	2	3.7	1	3.7	------	------	------	------	------	------	1	4.5	5	4.1
34.5	------	------	------	------	------	------	------	------	------	------	------	------	------	------
35.0	------	------	1	4.3	------	------	------	------	1	4.5	------	------	1	4.5
35.5	------	------	------	------	------	------	------	------	------	------	------	------	------	------
36.0	------	------	------	------	------	------	2	4.4	------	------	1	4.0	4	5.2
36.5	------	------	------	------	------	------	------	------	------	------	------	------	1	5.4
37.0	------	------	------	------	------	------	------	------	1	5.0	------	------	2	6.4
37.5	------	------	------	------	------	------	------	------	------	------	1	6.3	1	7.3
38.0	------	------	------	------	------	------	------	------	------	------	------	------	1	5.5

TABLE 17—Continued

Length-weight and Length-frequency of Longnose Gar Taken in the Haul Seine
Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	May 1954		June 1954		July 1954		Aug. 1954		Sept. 1954		Oct. 1954		Total 1953-1954	
	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.
25.0	1	2.0	......	......					......				1	2.0
25.5	1	1.5	......	......					......				3	1.5
26.0	1	2.2	......	......		......	......	......	......	......	1	2.1	2	2.2
26.5	......	......	1	1.9		......	......	......	......	......	......	......	5	1.7
27.0	......	......	......	......	......	......	......	......	......	......	......	......	......	......
27.5	......	......	1	2.1	......	......	......	......	......	......	......	......	2	2.0
28.0	......	......	1	2.0	1	2.2	......	......	......	......	1	1.7	3	2.0
28.5	......	......	1	2.0	......	......	2	2.0	......	......	......	......	3	2.0
29.0	4	2.4	......	......	......	......	......	......	......	......	......	......	9	2.4
29.5	......	......	......	......	......	......	1	2.0	......	......	1	2.0	2	2.0
30.0	2	2.8	2	2.7		......	1	2.3	......	......	......	......	14	2.7
30.5	1	2.5	1	2.7		......	1	2.4	1	2.4	......	......	14	2.7
31.0	1	3.0	1	3.2		......	......	......	3	2.8	......	......	16	3.0
31.5	......	......	......	......	......	......	......	......	2	2.5	......	......	6	3.2
32.0	3	3.2	1	3.4	1	3.0	1	3.0	......	......	......	......	15	3.4
32.5	1	4.0	1	3.3		......		......	2	3.6	......	......	9	3.4
33.0	1	3.6	2	3.6	......		......	......	......	......	1	3.3	13	3.5
33.5	......	......	3	3.5	......	......	......	......	1	3.7	......	......	7	3.6
34.0	......	......	......	......	1	4.8	2	4.8	......	......	1	3.5	13	4.1
34.5	1	3.2	......	......	......	......	1	4.0	......	......	......	......	2	3.6
35.0	......	......	......	......	1	4.2	......	......	......	......	......	......	4	4.4
35.5	......	......	1	4.4	......	......	......	......	......	......	......	......	1	4.4
36.0	1	6.0	......	......	......	......	1	4.3	......	......	......	......	9	4.9
36.5	......	......	......	......	......	......	......	......	......	......	......	......	1	5.4
37.0	......	......	......	......	......	......	......	......	......	......	......	......	3	5.9
37.5	1	6.0	......	......	......	......	......	......	......	......	......	......	3	6.5
38.0	......	......	......	......	......	......	......	......	1	6.0	......	......	2	5.8

TABLE 17—Continued

Length-weight and Length-frequency of Longnose Gar Taken in the Haul Seine Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	Oct. 1953		Nov. 1953		Dec. 1953		Jan. 1954		Feb. 1954		Mar. 1954		Apr. 1954	
	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.
39.0	......	......	......	......	......	......	......	......	......	......	......	......	......	......
39.5	......	......	......	......	......	......	......	......	......	......	......	......	1	8.0
40.0	......	......	1	26.0	......	......	......	......	1	7.2	......	......	5	7.8
41.0	......	......	......	......	......	......	......	......	......	......	......	......	......	......
42.0	......	......	......	......	......	......	......	......	......	......	......	......	......	......
43.0	......	......	......	......	......	......	......	......	......	......	......	......	1	12.0
45.0	......	......	......	......	......	......	......	......	......	......	2	14.2	......	......
46.0	......	......	......	......	......	......	......	......	......	......	......	......	......	......
47.0	......	......	......	......	......	......	......	......	......	......	......	......	2	13.3
47.5	......	......	......	......	......	......	......	......	......	......	......	......	......	......
48.0	......	......	......	......	......	......	......	......	1	20.0	......	......	......	......
49.0	......	......	......	......	......	......	......	......	......	......	......	......	......	......
50.0	......	......	......	......	......	......	1	19.0	......	......	......	......	2	21.0
50.5	......	......	......	......	......	......	......	......	......	......	......	......	1	20.0
51.0	......	......	......	......	......	......	......	......	......	......	1	19.5	......	......
52.0	......	......	......	......	......	......	......	......	......	......	1	23.8	......	......
52.5	......	......	......	......	......	......	......	......	......	......	......	......	1	27.0
53.0	......	......	......	......	......	......	......	......	......	......	......	......	......	......
54.0	......	......	......	......	......	......	......	......	......	......	2	23.3	1	28.1
55.5	......	......	......	......	......	......	......	......	......	......	......	......	1	26.0
56.0	......	......	1	27.0	......	......	......	......	1	32.0	1	26.5	2	19.8
56.5	......	......	......	......	......	......	......	......	......	......	......	......	......	......
57.0	......	......	......	......	......	......	......	......	......	......	......	......	1	30.0
58.0	......	......	......	......	......	......	......	......	......	......	1	35.0	2	32.0
59.0	......	......	......	......	......	......	......	......	......	......	......	......	1	28.0
60.0	......	......	1	27.0	......	......	......	......	1	35.5	......	......	......	......
63.0	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Totals	4	......	17	......	1	......	8	......	7	......	16	......	82	......

TABLE 17—Continued

Length-weight and Length-frequency of Longnose Gar Taken in the Haul Seine
Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	May 1954 No.	May 1954 Av. Wt.	June 1954 No.	June 1954 Av. Wt.	July 1954 No.	July 1954 Av. Wt.	Aug. 1954 No.	Aug. 1954 Av. Wt.	Sept. 1954 No.	Sept. 1954 Av. Wt.	Oct. 1954 No.	Oct. 1954 Av. Wt.	Total 1953-1954 No.	Total 1953-1954 Av. Wt.
39.0	2	11.3	......	......	......	......	......	......	......	......	......	......	2	11.3
39.5	......	......	......	......	......	......	......	......	......	......	......	......	1	8.0
40.0	......	......	......	......	......	......	......	......	......	......	......	......	7	10.3
41.0	......	......	......	......	......	......	......	......	1	7.2	......	......	1	7.2
42.0	1	11.6	1	9.4	......	......	......	......	......	......	......	......	2	10.5
43.0	1	9.4	......	......	1	11.0	......	......	......	......	......	......	3	10.8
45.0	1	26.6	......	......	1	12.6	......	......	......	......	......	......	4	16.9
46.0	......	......	1	14.1	......	......	1	14.5	1	14.0	......	......	3	14.2
47.0	......	......	......	......	......	......	1	16.3	......	......	......	......	3	14.3
47.5	2	18.9	......	......	......	......	......	......	......	......	......	......	2	18.9
48.0	......	......	......	......	1	18.2	1	15.0	......	......	......	......	3	17.7
49.0	......	......	......	......	......	......	1	17.3	......	......	......	......	1	17.3
50.0	......	......	......	......	......	......	......	......	......	......	......	......	3	20.3
50.5	......	......	......	......	......	......	......	......	......	......	......	......	1	20.0
51.0	......	......	......	......	1	21.0	......	......	......	......	......	......	2	20.3
52.0	2	20.2	1	22.2	1	25.0	1	21.5	......	......	......	......	6	22.0
52.5	......	......	......	......	......	......	......	......	......	......	......	......	1	27.0
53.0	1	20.0	1	22.8	1	22.6	......	......	......	......	......	......	3	21.8
54.0	2	25.1	......	......	2	25.5	......	......	......	......	......	......	7	25.1
55.5	......	......	......	......	......	......	......	......	......	......	......	......	1	26.0
56.0	......	......	1	27.0	3	22.7	......	......	......	......	1	27.0	10	24.7
56.5	1	30.0	......	......	......	......	......	......	......	......	......	......	1	30.0
57.0	1	31.0	......	......	......	......	......	......	......	......	......	......	2	30.5
58.0	......	......	......	......	......	......	......	......	......	......	1	37.5	4	34.1
59.0	......	......	......	......	......	......	1	29.8	......	......	......	......	2	28.9
60.0	1	34.0	......	......	......	......	......	......	......	......	......	......	3	32.2
63.0	......	......	......	......	......	......	1	40.5	......	......	......	......	1	40.5
Totals	34	......	21	......	15	......	17	......	12	......	7	......	241	......

TABLE 18

Length-weight of Florida Spotted Gar Taken in the Haul Seine
Lake Panasoffkee, November 1953 Through October 1954

Total Length in Inches	Nov. 1953		Dec. 1953		Mar. 1954		Apr. 1954		May 1954	
	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.
19.0	------	------	1	1.0	------	------	1	1.0	------	------
20.0	------	------	1	1.2	------	------	2	1.4	------	------
20.5	------	------	------	------	------	------	------	------	2	1.3
21.0	------	------	------	------	------	------	1	1.4	2	1.8
21.5	------	------	------	------	1	2.4	2	1.5	1	1.4
22.0	------	------	------	------	------	------	------	------	------	------
22.5	------	------	------	------	------	------	------	------	1	1.8
23.0	------	------	------	------	------	------	------	------	1	1.9
26.5	1	3.4	------	------	------	------	------	------	------	------
Totals	1	------	2	------	1	------	6	------	7	------

TABLE 18—Continued

Length-weight of Florida Spotted Gar Taken in the Haul Seine
Lake Panasoffkee, November 1953 Through October 1954

Total Length in Inches	June 1954 No.	June 1954 Av. Wt.	Aug. 1954 No.	Aug. 1954 Av. Wt.	Sept. 1954 No.	Sept. 1954 Av. Wt.	Oct. 1954 No.	Oct. 1954 Av. Wt.	Total 1953-1954 No.	Total 1953-1954 Av. Wt.
19.0	......	......	......	......	......	......	......	......	2	1.0
20.0	1	1.8	1	1.3	......	......	1	1.3	6	1.4
20.5	......	......	......	......	......	......	......	......	2	1.3
21.0	......	......	......	......	1	1.0	......	......	4	1.5
21.5	1	1.3	......	......	......	......	......	......	5	1.6
22.0	1	2.3	......	......	......	......	1	2.3	2	2.3
22.5	......	......	......	......	......	......	......	......	1	1.8
23.0	......	......	......	......	......	......	......	......	1	1.9
26.5	......	......	......	......	......	......	......	......	1	3.4
Totals	3	......	1	......	1	......	2	......	24	......

TABLE 19

Length-frequency of Chub Sucker Taken in Haul Seine
Lake Panasoffkee, April and September 1954

Total Length in Inches	April 1954 No.	April 1954 Per cent	Sept. 1954 No.	Sept. 1954 Per cent	Total No.	Total Per cent
10.0	1	1	------	------	1	1
10.5	1	1	------	------	1	1
11.0	3	4	------	------	3	3
12.0	11	13	1	14	12	14
12.5	19	23	1	14	20	23
13.0	18	22	2	28	20	23
13.5	15	18	1	14	16	18
14.0	7	9	1	14	8	9
14.5	5	6	1	14	6	7
15.0	2	2	------	------	2	2
Totals	82	------	7	------	89	------
Av. Length	12.9	------	13.2	------	12.9	------

TABLE 20

Length-frequency of Golden Shiner Taken in Haul Seine
Lake Panasoffkee, October 1953

Total Length in Inches	No.	Percentage
10.0	2	12
10.5	3	18
11.0	6	35
11.5	3	18
12.0	3	18
Total	17	------

TABLE 21

Length-weight of Largemouth Bass Taken in the Haul Seine From Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	Oct. 1953		Nov. 1953		Dec. 1953		Jan. 1954		Feb. 1954		Mar. 1954		Apr. 1954	
	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.
9.0	......	......	......	......	......	......	......	......	......	......	......	......	1	.3
9.5	1	.5	......	......	......	......	......	......	......	......	......	......	......	......
10.0	6	.5	......	......	......	......	......	......	......	......	......	......	1	.6
10.5	8	.6	......	......	2	.7	1	.4	......	......	......	......	3	.6
11.0	11	.7	......	......	......	......	2	.5	......	......	......	......	......	......
11.5	5	.8	......	......	......	......	5	.5	1	.7	......	......	2	.7
12.0	5	.8	......	......	......	......	2	.7	1	.8	......	......	1	.9
12.5	5	.9	1	.7	2	.9	......	......	......	......	......	......	......	......
13.0	2	1.0	......	......	......	......	1	.9	1	1.0	......	......	1	1.0
14.0	2	1.3	......	......	2	1.3	......	......	1	1.2	......	......	1	1.3
14.5	1	1.6	......	......	......	......	......	......	......	......	1	1.5	......	......
15.0	1	1.6	......	......	......	......	......	......	......	......	......	......	......	......
15.5	......	......	......	......	2	1.8	......	......	......	......	1	2.0	......	......
16.0	1	2.0	......	......	2	2.0	......	......	......	......	1	2.2	......	......
16.5	2	2.2	......	......	......	......	......	......	......	......	1	2.5	2	2.4
17.0	......	......	......	......	......	......	......	......	......	......	......	......	......	......
17.5	......	......	......	......	......	......	1	3.0	......	......	......	......	1	4.0
18.0	......	......	......	......	......	......	......	......	......	......	1	3.0	2	3.0
18.5	......	......	......	......	1	3.5	......	......	1	3.4	......	......	2	3.5
19.0	......	......	1	3.3	1	4.0	1	3.9	1	3.9	2	4.0	1	4.0
19.5	1	3.8	......	......	......	......	1	4.3	......	......	......	......	......	......
20.0	1	4.1	......	......	4	4.7	3	4.5	4	4.8	1	3.9	5	5.3
20.5	1	4.5	......	......	2	4.6	2	5.1	5	4.9	2	4.7	3	4.5
21.0	......	......	......	......	6	4.8	3	5.5	3	4.9	1	4.6	7	5.4
21.5	......	......	3	6.1	5	5.5	2	6.2	3	5.8	......	......	3	5.4
22.0	1	6.0	......	......	2	6.9	......	......	......	......	2	6.8	2	6.4
22.5	......	......	......	......	1	7.2	1	7.7	2	7.3	......	......		......
23.0	......	......	1	7.7	2	7.6	......	......	2	8.7	3	7.9		......
23.5	......	......	......	......	......	......	......	......	......	......	......	......	1	7.2
24.0	......	......	1	9.0	......	......	......	......	2	8.2	......	......	2	8.3
24.5	......	......	1	9.8	1	10.4	......	......	......	......	......	......	......	......
25.0	......	......	......	......	3	10.0	......	......	1	10.1	2	9.2	1	8.5
25.5	......	......	......	......	......	......	......	......	1	10.0	......	......	......	......
Totals	54	......	8	......	37	......	25	......	30	......	19	......	42	......

TABLE 21—Continued

Length-weight of Largemouth Bass Taken in the Haul Seine From Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	May 1954 No.	May 1954 Av. Wt.	June 1954 No.	June 1954 Av. Wt.	July 1954 No.	July 1954 Av. Wt.	Aug. 1954 No.	Aug. 1954 Av. Wt.	Sept. 1954 No.	Sept. 1954 Av. Wt.	Oct. 1954 No.	Oct. 1954 Av. Wt.	Total 1953-1954 No.	Total 1953-1954 Av. Wt.
9.0	1	.3	......	......	......	......	......	......	......	......	......	......	2	.3
9.5	......	......	......	......	......	......	1	.5	......	......	......	......	2	.5
10.0	......	......	......	......	......	......	1	.6	......	......	......	......	8	.5
10.5	1	.5	1	.7	......	......	1	.6	......	......	......	......	17	.6
11.0	1	.7	......	......	......	......	1	.7	......	......	......	......	15	.7
11.5	2	.7	......	......	......	......	1	.7	......	......	......	......	16	.7
12.0	......	......	1	.8	......	......	......	......	......	......	......	......	10	.8
12.5	......	......	......	......	......	......	......	......	......	......	......	......	8	.9
13.0	2	1.1	......	......	......	......	......	......	......	......	......	......	7	1.0
14.0	......	......	......	......	......	......	......	......	......	......	......	......	6	1.3
14.5	......	......	1	1.8	......	......	......	......	......	......	......	......	3	1.6
15.0	1	1.9	......	......	......	......	1	1.8	......	......	......	......	3	1.8
15.5	......	......	......	......	......	......	1	1.8	......	......	......	......	4	1.9
16.0	......	......	......	......	......	......	......	......	......	......	......	......	5	2.1
16.5	1	2.3	1	2.6	......	......	......	......	......	......	......	......	7	2.4
17.0	......	......	......	......	......	......	1	3.0	......	......	......	......	1	3.0
17.5	1	2.8	......	......	1	3.0	......	......	......	......	......	......	4	3.2
18.0	......	......	......	......	......	......	1	3.6	......	......	......	......	4	3.2
18.5	2	3.6	1	4.0	......	......	1	4.4	......	......	......	......	8	3.7
19.0	......	......	......	......	3	4.7	......	......	......	......	......	......	10	4.1
19.5	2	4.8	......	......	2	4.8	......	......	......	......	......	......	6	4.6
20.0	......	......	......	......	1	5.5	3	5.0	......	......	......	......	22	4.8
20.5	2	5.5	......	......	1	5.8	1	5.0	......	......	......	......	19	4.9
21.0	7	5.2	1	5.9	......	......	5	5.8	......	......	......	......	33	5.3
21.5	1	6.6	4	5.7	2	6.3	3	6.2	1	7.0	......	......	27	5.9
22.0	1	6.7	2	6.6	1	6.4	3	7.1	......	......	......	......	14	6.7
22.5	......	......	......	......	1	6.4	1	7.6	......	......	......	......	6	7.3
23.0	2	7.1	......	......	3	7.6	1	8.0	1	7.0	1	7.7	16	7.8
23.5	......	......	......	......	......	......	1	8.4	......	......	......	......	3	8.0
24.0	......	......	......	......	......	......	......	......	......	......	......	......	5	8.4
24.5	......	......	......	......	......	......	1	9.3	......	......	......	......	3	9.8
25.0	......	......	......	......	......	......	......	......	......	......	......	......	7	9.6
25.5	......	......	......	......	......	......	......	......	......	......	......	......	1	10.0
Totals	27	......	12	......	15	......	30	......	2	......	1	......	302	......

TABLE 22

Length-weight of Black Crappie Taken in the Haul Seine Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	Oct. 1953		Dec. 1953		Feb. 1954		Mar. 1954		Apr. 1954	
	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.
8.0	------	------	------	------	------	------	------	------	1	.2
8.5	1	.3	------	------	------	------	------	------	2	.3
10.0	3	.4	1	1.0	------	------	------	------	2	.5
10.5	4	.6	------	------	3	.6	------	------	3	.5
11.0	4	.7	1	.6	1	.6	------	------	3	.8
11.5	1	.8	------	------	4	.7	1	.8	1	1.1
12.0	7	1.0	------	------	3	.9	2	.7	7	.9
12.5	1	1.1	------	------	6	1.1	5	.9	2	1.2
13.0	1	1.1	2	1.5	2	1.0	1	1.0	1	1.2
13.5	1	2.2	------	------	2	1.4	1	1.0	1	1.3
14.0	4	1.6	1	1.6	3	1.6	3	1.2	4	1.4
14.5	------	------	------	------	4	1.6	2	1.5	7	1.6
15.0	1	1.8	2	2.2	------	------	1	1.8	3	1.5
Totals	32	------	7	------	28	------	16	------	37	------

TABLE 22—Continued

Length-weight of Black Crappie Taken in the Haul Seine
Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	May 1954		June 1954		Aug. 1954		Sept. 1954		Oct. 1954		Total 1953-1954	
	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.
8.0	1	.4	......	......	......	......	......	......	......	......	2	.3
8.5	......	......	......	......	......	......	......	......	......	......	3	.3
10.0	......	......	......	......	......	......	......	......	......	......	6	.5
10.5	......	......	......	......	......	......	......	......	......	......	10	.6
11.0	1	.7	......	......	......	......	......	......	......	......	8	.7
11.5	......	......	......	......	......	......	......	......	......	......	7	.8
12.0	3	.9	......	......	......	......	......	......	......	......	22	.9
12.5	3	1.1	1	1.0	1	1.1	......	......	1	1.0	26	1.1
13.0	2	1.2	1	1.2	......	......	......	......	......	......	10	1.2
13.5	1	1.3	1	1.3	......	......	......	......	......	......	7	1.4
14.0	2	1.7	1	1.8	......	......	......	......	......	......	18	1.5
14.5	4	1.6	1	1.6	......	......	......	......	......	......	18	1.6
15.0	4	1.7	1	1.9	......	......	......	......	......	......	12	1.8
Totals	21	......	6	......	1	......	......	......	1	......	149	......

TABLE 23

Length-weight of Bluegill Taken in the Haul Seine
Lake Panasoffkee, October 1953 Through May 1954

Total Length in Inches	Oct. 1953		Feb. 1954		Mar. 1954		May 1954		Total 1953-1954	
	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.
6.5	2	.2	......	......	1	.2	3	.3	6	.3
7.0	5	.3	2	.3	3	.3	......	......	10	.3
7.5	2	.3	6	.2	4	.5	2	.4	14	.3
8.0	2	.4	11	.3	......	......	2	.6	15	.4
8.5	1	.5	3	.4	4	.6	1	.6	9	.5
9.0	......	......	2	.5	2	.7	......	......	4	.6
9.5	......	......	1	.8	1	.9	......	......	2	.9
10.0	......	......	1	1.0	1	1.1	......	......	2	1.1
10.5	......	......	......	......	2	1.0	......	......	2	1.0
Totals	12	......	26	......	18	......	8	......	64	......

TABLE 24

Length-weight of the Shellcracker Taken in the Haul Seine, Lake Panasoffkee, October 1953 Through August 1954

Total Length in Inches	Oct. 1953		Nov. 1953		Dec. 1953		Jan. 1954		Feb. 1954		Mar. 1954	
	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.
6.0	......	......	......	......	......	......	......	......	......	......	1	.3
7.0	......	......	......	......	......	......	......	......	1	.2	2	.3
7.5	......	......	......	......	......	......	......	......	1	.2	2	.3
8.0	1	.5	......	......	......	......	......	......	3	.4	7	.5
8.5	......	......	......	......	......	......	......	......	......	......	7	.6
9.0	2	.7	......	......	......	......	......	......	4	.5	2	.6
9.5	2	.6	......	......	......	......	......	......	3	.6	2	.7
10.0	2	.7	......	......	......	......	......	......	2	.7	2	.7
10.5	......	......	......	......	......	......	......	......	1	1.0	3	.9
11.0	1	.8	......	......	......	......	......	......	2	1.1	7	1.1
11.5	......	......	1	1.4	1	1.2	......	......	1	1.8	2	1.4
12.0	3	1.4	1	1.4	1	2.1	......	......	3	1.8	3	2.0
12.5	......	......	......	......	2	1.9	......	......	2	1.8	5	2.1
13.0	2	2.1	......	......	......	......	1	1.8	1	2.0	2	2.3
13.5	......	......	......	......	......	......	......	......	......	......	......	......
Totals	13	......	2	......	4	......	1	......	24	......	47	......

TABLE 24—Continued

Length-weight of the Shellcracker Taken in the Haul Seine, Lake Panasoffkee, October 1953 Through August 1954

Total Length in Inches	April 1954		May 1954		June 1954		July 1954		Aug. 1954		Total 1953-1954	
	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.
6.0	------	------	------	------	------	------	------	------	------	------	1	.3
7.0	------	------	------	------	------	------	------	------	------	------	3	.3
7.5	------	------	------	------	------	------	------	------	1	.3	4	.3
8.0	------	------	------	------	------	------	------	------	------	------	11	.5
8.5	------	------	1	.6	------	------	------	------	------	------	8	.6
9.0	------	------	3	.8	------	------	------	------	------	------	11	.6
9.5	------	------	------	------	------	------	------	------	------	------	7	.6
10.0	------	------	1	1.0	------	------	------	------	------	------	7	.7
10.5	------	------	3	1.1	------	------	------	------	------	------	7	1.0
11.0	1	1.5	1	1.2	------	------	------	------	1	1.5	13	1.1
11.5	2	2.4	3	1.6	------	------	2	1.7	1	1.7	13	1.7
12.0	2	2.2	6	2.0	------	------	------	------	------	------	19	1.9
12.5	------	------	5	2.3	3	2.3	2	2.2	3	2.2	22	2.2
13.0	------	------	4	2.5	------	------	2	2.6	2	2.5	14	2.3
13.5	------	------	1	2.8	------	------	------	------	------	------	1	2.8
Totals	5	------	28	------	3	------	6	------	8	------	141	------

TABLE 25

Length-weight of Channel Catfish Taken in the Haul Seine Lake Panasoffkee, November 1953 Through October 1954

Total Length in Inches	Nov. 1953 No.	Nov. 1953 Av. Wt.	Dec. 1953 No.	Dec. 1953 Av. Wt.	Jan. 1954 No.	Jan. 1954 Av. Wt.	Feb. 1954 No.	Feb. 1954 Av. Wt.	Apr. 1954 No.	Apr. 1954 Av. Wt.
30.0	....	....	....	....	1	14.0	....	....	....	....
30.5	1	17.0	....	....	....	....	....	....	....	....
31.0	....	....	....	....	....	....	....	....	....	....
32.0	....	....	....	....	1	18.0	1	16.0	....	....
33.0	....	....	....	....	....	....	1	17.3	....	....
34.0	....	....	1	24.5	....	....	....	....	1	27.0
36.0	....	....	1	21.0	....	....	....	....	....	....
37.0	....	....	....	....	....	....	....	....	....	....
Totals	1	....	2	....	2	....	2	....	1	....

TABLE 25—Continued

Length-weight of Channel Catfish Taken in the Haul Seine
Lake Panasoffkee, November 1953 Through October 1954

Total Length in Inches	Aug. 1954		Sept. 1954		Oct. 1954		Total 1953-1954	
	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.
30.0	------	------	------	------	------	------	1	14.0
30.5	------	------	------	------	------	------	1	17.0
31.0	------	------	1	14.3	------	------	1	14.3
32.0	------	------	------	------	------	------	2	17.0
33.0	------	------	------	------	------	------	1	17.3
34.0	2	16.7	------	------	------	------	4	21.2
36.0	------	------	------	------	------	------	1	21.0
37.0	------	------	------	------	1	21.0	1	21.0
Totals	2	------	1	------	1	------	12	------

TABLE 26

Length-weight of White Catfish Taken in the Haul Seine Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	Oct. 1953 No.	Oct. 1953 Av. Wt.	Dec. 1953 No.	Dec. 1953 Av. Wt.	Jan. 1954 No.	Jan. 1954 Av. Wt.	Feb. 1954 No.	Feb. 1954 Av. Wt.	Mar. 1954 No.	Mar. 1954 Av. Wt.	Apr. 1954 No.	Apr. 1954 Av. Wt.
10.5	....	....	....	....	....	....	1	.7	....	....	....	....
11.0	....	....	....	....	....	....	1	.8	....	....	1	.7
11.5	....	....	....	....	....	....	1	.8	....	....	1	1.0
12.0	1	.8	....	....	....	....	3	.9	1	.8	4	1.1
12.5	....	....	....	....	....	....			....	....	1	1.3
13.0	....	....	....	....	1	1.0	1	1.0	....	....	3	1.3
13.5	....	....	....	....	....	....	....	....	....	....	1	1.2
14.0	....	....	....	....	....	....	....	....	....	....	2	1.8
14.5	....	....	....	....	....	....	....	....	....	....	....	....
15.0	1	1.8	....	....	....	....	1	2.0	....	....	....	....
15.5	1	1.8	....	....	....	....	1	2.3	....	....	....	....
16.0	1	2.2	....	....	....	....	1	3.0	....	....	....	....
16.5	....	....	2	2.5	....	....	....	....	....	....	....	....
17.0	....	....	....	....	....	....	....	....	....	....	....	....
17.5	....	....	....	....	....	....	....	....	1	3.3	....	....
20.0	....	....	....	....	....	....	1	4.5	....	....	....	....
Totals	4	....	2	....	1	....	11	....	2	....	13	....

TABLE 26—Continued

Length-weight of White Catfish Taken in the Haul Seine
Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	May 1954		June 1954		Aug. 1954		Sept. 1954		Oct. 1954		Total 1953-1954	
	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.
10.5	......	......	......	......	......	......	......	......	......	......	1	.7
11.0	......	......	......	......	......	......	......	......	......	......	2	.8
11.5	1	.6	......	......	......	......	......	......	......	......	3	.8
12.0	......	......	......	......	......	......	......	......	......	......	9	1.0
12.5	4	1.1	......	......	......	......	1	.9	......	......	6	1.1
13.0	......	......	......	......	1	1.2	......	......	1	1.0	7	1.1
13.5	4	1.5	1	2.3	......	......	......	......	......	......	6	1.6
14.0	......	......	1	1.4	1	1.3	......	......	......	......	4	1.6
14.5	1	1.9	......	......	1	1.4	......	......	......	......	2	1.7
15.0	1	2.5	......	......	......	......	......	......	......	......	3	2.1
15.5	......	......	......	......	......	......	......	......	......	......	2	2.2
16.0	......	......	......	......	......	......	......	......	1	2.0	3	2.4
16.5	......	......	......	......	3	2.2	......	......	1	1.5	6	2.2
17.0	......	......	1	2.6	1	2.7	......	......	......	......	2	2.7
17.5	......	......	......	......	......	......	......	......	......	......	1	3.3
20.0	......	......	......	......	......	......	......	......	......	......	1	4.5
Totals	11	......	3	......	7	......	1	......	3	......	58	

TABLE 27

Length-weight of Speckled Bullhead Taken in the Haul Seine
Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	Oct. 1953		Nov. 1953		Dec. 1953		Jan. 1954		Feb. 1954		Mar. 1954		Apr. 1954	
	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.
9.5	......	......	......	......	......	......	......	......	......	......	......	......	1	.4
10.0	......	......	......	......	......	......	......	......	......	......	......	......	1	.5
10.5	......	......	......	......	......	......	......	......	......	......	......	......	1	.7
11.0	......	......	......	......	......	......	......	......	......	......	......	......	2	1.2
11.5	......	......	......	......	......	......	......	......	......	......	......	......	6	.9
12.0	1	1.0	......	......	......	......	......	......	......	......	......	......	5	1.2
12.5	......	......	......	......	......	......	......	......	......	......	......	......	6	1.1
13.0	2	1.1	3	1.8	......	......	......	......	......	......	1	1.3	1	1.5
13.5	......	......	1	1.9	......	......	......	......	......	......	......	......	4	1.3
14.0	4	1.8	3	1.8	......	......	1	1.8	......	......	......	......	4	1.9
14.5	......	......	......	......	......	......	......	......	1	2.1	......	......	10	2.0
15.0	1	2.2	2	2.1	......	......	......	......	......	......	......	......	5	2.3
15.5	1	2.1	......	......	......	......	2	2.3	......	......	1	2.8	8	2.6
16.0	3	2.5	2	2.8	......	......	......	......	1	3.0	......	......	9	2.6
16.5	1	3.0	3	3.0	1	3.2	1	3.2	......	......	......	......	4	2.8
17.0	1	2.4	......	......	......	......	......	......	......	......	......	......	2	3.3
17.5	......	......	......	......	......	......	1	3.0	......	......	1	4.3	2	3.6
18.0	2	2.9	3	3.5	4	3.7	1	3.5	......	......	1	4.0	18	3.6
18.5	......	......	1	4.3	3	4.3	......	......	1	4.0	2	4.3	13	3.9
19.0	1	3.6	......	......	......	......	......	......	2	4.2	......	......	7	4.2
19.5	......	......	......	......	......	......	......	......	......	......	1	4.5	1	4.8
20.0	......	......	......	......	......	......	......	......	......	......	1	4.6	......	......
Totals	17	......	18	......	8	......	6	......	5	......	8	......	110	......

TABLE 27—Continued

Length-weight of Speckled Bullhead Taken in the Haul Seine
Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	May 1954 No.	May 1954 Av. Wt.	June 1954 No.	June 1954 Av. Wt.	Aug. 1954 No.	Aug. 1954 Av. Wt.	Sept. 1954 No.	Sept. 1954 Av. Wt.	Oct. 1954 No.	Oct. 1954 Av. Wt.	Total 1953-1954 No.	Total 1953-1954 Av. Wt.
9.5	......	......	......	......	......	......	......	......	......	......	1	.4
10.0	1	.6	......	......	......	......	......	......	......	......	2	.6
10.5	......	......	......	......	5	.7	......	......	......	......	6	.7
11.0	3	.8	......	......	7	.7	......	......	......	......	12	.8
11.5	1	.9	1	.9	6	.7	......	......	......	......	14	.8
12.0	2	1.0	......	......	9	1.0	......	......	......	......	17	1.1
12.5	2	1.2	......	......	6	.8	......	......	......	......	14	1.0
13.0	2	1.2	1	.9	9	1.1	......	......	......	......	19	1.2
13.5	2	1.4	......	......	6	1.3	......	......	......	......	13	1.4
14.0	3	1.6	1	1.8	6	1.5	......	......	......	......	22	1.7
14.5	4	1.9	1	2.1	8	1.7	......	......	......	......	24	1.9
15.0	10	2.1	1	1.9	10	1.9	......	......	1	1.7	30	2.1
15.5	4	2.2	......	......	8	2.1	......	......	......	......	24	2.3
16.0	5	2.6	2	2.3	8	2.3	......	......	......	......	30	2.5
16.5	......	......	2	2.6	3	2.7	......	......	......	......	15	2.9
17.0	3	3.0	3	2.9	6	3.2	......	......	......	......	15	3.1
17.5	4	3.5	1	3.5	1	3.5	......	......	......	......	10	3.6
18.0	1	3.5	3	3.5	6	3.3	......	......	......	......	39	3.5
18.5	......	......	1	3.7	2	3.3	1	3.4	......	......	24	3.9
19.0	3	4.1	2	4.1	1	4.4	......	......	......	......	16	4.1
19.5	2	4.5	......	......	......	......	......	......	1	4.7	5	4.6
20.0	......	......	......	......	......	......	......	......	......	......	1	4.6
Totals	52	......	19	......	107	......	1	......	2	......	353	......

TABLE 28

Length-weight of Gizzard Shad Taken in the Haul Seine
Lake Panasoffkee, February 1954 Through September 1954

Total Length in Inches	Feb. 1954		Mar. 1954		Apr. 1954		May 1954		Aug. 1954		Sept. 1954		Total	
	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.
11.0	...	...	1	.6	8	.6	1	.4	...	...	...	...	10	.6
11.5	...	...	...	...	6	.6	8	.6	...	...	...	...	14	.6
12.0	1	.6	...	...	16	.8	12	.7	...	...	...	...	29	.8
12.5	...	...	...	...	5	.8	4	.7	...	...	...	...	9	.8
13.0	...	...	...	...	...	...	1	.9	...	...	...	...	1	.9
13.5	...	...	...	...	1	1.0	1	1.3	...	...	...	...	2	1.2
14.0	1	1.0	...	...	...	...	...	...	...	...	...	...	1	1.0
15.0	...	...	...	...	...	...	1	1.4	...	...	...	...	1	1.4
16.5	...	...	...	...	...	...	...	...	1	2.4	...	...	1	2.4
17.0	...	...	...	...	1	2.4	...	...	...	...	...	...	1	2.4
17.5	...	...	...	...	1	2.6	...	...	...	...	...	...	1	2.6
18.0	...	...	1	3.0	...	...	1	2.9	...	...	...	...	2	3.0
Totals	2	...	2	...	38	...	29	...	1	...	...	...	72	...

TABLE 29

Length-weight of Chub Sucker Taken in the Haul Seine, Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	Oct. 1953		Mar. 1954		April 1954		May 1954	
	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.
9.5	......	......	1	.4			......	......
10.0	......	......	1	.5		......	......	......
11.0	......	......	1	.6	1	.7	......	......
11.5	2	.8	1	.7	......	......	1	1.0
12.0	......	......	......	......		......		
12.5	......	......	......	......	2	1.1		
13.0	......	......	......	......	4	1.3		
13.5	......	......	......	......	4	1.4		
14.0	......	......	......	......	2	1.6		
14.5	......	......	......	......	1	1.8	......	......
15.0	......	......	......	......	......	......	1	2.0
15.5	......	......	......	......	1	2.2	......	......
Totals	2	......	4	......	15	......	2	......

TABLE 29—Continued

Length-weight of Chub Sucker Taken in the Haul Seine, Lake Panasoffkee, October 1953 Through October 1954

Total Length in Inches	July 1954		Aug. 1954		Sept. 1954		Oct. 1954		Total 1953-1954	
	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.	No.	Av. Wt.
9.5	------	------	------	------	------	------	------	------	1	.4
10.0	------	------	------	------	------	------	------	------	1	.5
11.0	------	------	1	.8	------	------	------	------	3	.7
11.5	1	.9	2	.8	------	------	------	------	7	.8
12.0	1	1.0	5	1.1	------	------	2	.9	8	1.0
12.5	1	1.1	2	1.2	1	1.1	1	1.0	7	1.1
13.0	------	------	1	1.6	------	------	1	1.0	6	1.3
13.5	1	1.3	2	1.7	------	------	1	1.4	8	1.5
14.0	1	1.7	------	------	------	------	------	------	3	1.6
14.5	------	------	------	------	------	------	------	------	1	1.8
15.0	------	------	------	------	------	------	------	------	1	2.0
15.5	------	------	------	------	------	------	------	------	1	2.2
Totals	5	------	13	------	1	------	5	------	47	------

TABLE 30

Length-weight of Chain Pickerel Taken in the Haul Seine
Lake Panasoffkee, February 1954 Through October 1954

Total Length in Inches	Feb. 1954 No.	Feb. 1954 Av. Wt.	Sept. 1954 No.	Sept. 1954 Av. Wt.	Oct. 1954 No.	Oct. 1954 Av. Wt.	Total 1954 No.	Total 1954 Av. Wt.
18.0	-----	-----	1	1.3	-----	-----	1	1.3
20.5	-----	-----	-----	-----	1	2.0	1	2.0
23.0	1	3.5	-----	-----	-----	-----	1	3.5
Totals	1	-----	1	-----	1	-----	3	-----

TABLE 31

Average Catch from Seine Hauls
in Withlacoochee River Near Lake Panasoffkee

Date	May 1-4, 1951				April 26, 1954	
Net Size	835 yds., 3 inch Min.				1,000 yds., 3 inch Min.	
Average Area	22 Acres				25 Acres	
Number Hauls	4				1	
Species:	Lbs.	% Comp.	No.	% Comp.	Lbs.	% Comp.
Bass	19	4.1	50	15.1	66	21.0
Crappie	1	0.2	0	-------	-------	-------
Bluegill	60	13.2	91	27.4	23	7.3
Shellcracker	29	6.4	92	27.7	45	14.3
Redbreast	4	0.9	16	4.8	5	1.6
Warmouth	0	-------	9	2.7	4	1.3
Stumpknocker	0	-------	15	4.5	6	1.9
Chain Pickerel	0	-------	2	0.6	3	1.0
Channel Catfish	22	4.9	-------	-------	-------	-------
Speckled Bullhead	5	1.1	1	0.3	2	0.6
Longnose Gar	118	26.3	10	3.0	90	28.7
Florida Gar	2	0.5	9	2.7	27	8.6
Mudfish	0	-------	7	2.1	21	6.7
Gizzard Shad	178	39.6	2	0.6	3	1.0
Chub Sucker	12	2.7	16	4.8	12	3.8
Golden Shiner	-------	0.1	12	3.6	7	2.2
Total Fish	450	100.0	332	99.9	314	100.0
Non-Game Fish	337	79.4	57	17.2	162	51.6
Soft Shell Turtle	0	0	1	0.3	1	0.3
Terrapin	112	16.9	20	5.7	73	3.8

TABLE 32

Haul Seine Catch
Average Numbers Per Haul
Lake Panasoffkee

	Golden Shiner	Chub Sucker	Softshell Turtle	Speckled Bullhead	Longnose Gar
October 1953	81.0	1.9	0.4	1.1	31.9
November	32.9	1.1	0.1	5.1	68.3
December	6.6	0.0	0.0	2.0	89.6
January 1954	0.1	0.0	0.0	8.1	109.4
February	8.1	0.0	0.0	1.6	49.5
March	0.2	0.3	0.0	0.7	39.8
April	0.0	12.7	0.3	22.7	64.1
May	0.0	44.5	0.5	22.4	47.8
June	0.0	11.5	1.0	17.0	27.5
July	0.0	10.3	0.6	21.2	43.2
August	0.0	12.1	2.4	19.7	29.8
September	0.0	8.6	0.6	23.7	22.4
October	1.8	26.5	0.6	16.4	41.9

TABLE 33

Haul Seine Catch
Average Numbers Per Haul
Lake Panasoffkee

	Bass	Crappie	Bluegill	Shell-cracker	Gizzard Shad	Florida Gar	Terrapin
October 1953	80	194	295	250	1,512	0.9	3.9
November	179	77	642	694	1,649	2.0	11.3
December	107	20	460	848	981	3.1	13.2
January 1954	29	21	538	857	3,364	0.4	10.4
February	36	12	215	390	725	1.1	5.5
March	42	14	303	310	1,171	1.8	16.0
April	78	14	1,071	948	2,091	0.8	19.7
May	54	31	244	409	819	0.9	12.4
June	59	2	100	273	753	1.2	10.8
July	103	4	474	608	1,146	1.2	19.5
August	84	27	346	973	924	0.6	15.1
September	82	24	103	337	703	0.9	21.4
October	112	41	192	444	1,114	2.5	30.5

TABLE 34

Numbers Fishermen Interviewed, Total Hours They Fished, and Number of Days Creel Census Was Taken

	No. Fishermen Contacted	No. Days of Census	Total Hours Spent Fishing
March 1954	34	7	94
April	710	14	1,693
May	826	20	2,182
June	921	16	1,832
July	843	17	1,737
August	626	16	948
September	340	18	564
October	357	21	668
November	227	22	338
December	24	10	33
January 1955	89	7	193
February	132	7	256
March	81	5	113
April	296	7	669
May	214	7	475
June	175	7	442
July	180	7	378
August	169	5	412
Totals	6,244	213	13,027

TABLE 35

Sport Catch
Directed Effort for Bass

Month	Total Hours Spent	Total Number Fishermen For Bass	Number Bass Caught	* Average Bass Per Fisherman	* Average Time Spent When Checked	Catch Per Man Hour
March 1954	34.8	13	23	1.77	2.68	0.66
April 1954	543.8	228	327	1.43	2.39	0.60
May 1954	955.3	362	495	1.37	2.64	0.52
June 1954	360.8	181	215	1.19	1.99	0.60
July 1954	200.4	98	128	1.31	2.04	0.64
Aug. 1954	219.0	145	102	0.70	1.51	0.46
Sept. 1954	211.5	128	101	0.79	1.65	0.48
Oct. 1954	227.8	122	131	1.07	1.87	0.57
Nov. 1954	142.5	96	58	0.60	1.48	0.41
Dec. 1954	15.0	11	11	1.00	1.36	0.74
Jan. 1955	150.0	72	79	1.10	2.08	0.53
Feb. 1955	166.0	90	45	0.50	1.84	0.27
March 1955	79.5	57	51	0.89	1.39	0.64
April 1955	195.5	86	150	1.74	2.27	0.77
May 1955	77.5	35	42	1.20	2.21	0.54
June 1955	31.3	12	19	1.58	2.61	0.61
July 1955	72.3	34	41	1.21	2.13	0.57
Aug. 1955	121.0	50	55	1.10	2.42	0.45
Totals and Means	3804.0	1820	2073	1.1	2.0	0.6

Average weight Bass caught: 0.71 Lbs.

* The manner in which the data was collected causes it to reflect results near the mid-point of the fishing periods. Hence the actual catch per fisherman and the time spent appear to be about double the values shown.

TABLE 36

Sport Catch
Directed Effort for Crappie

Month	Total Hours Spent	Total Number Fishermen For Crappie	Number Crappie Caught	Average* Crappie Per Fisherman	Average* Time Spent When Checked	Catch Per Man Hour
March 1954	3.0	1	1	1.00	3.0	0.33
April	16.5	7	31	4.43	2.36	1.88
May	0.5	0	1	—	—	—
June	No Effort	No Effort	0	0	0	0
July	No Effort	No Effort	0	0	0	0
August	17.0	11	32	2.91	1.55	1.88
September	1.5	1	4	4.00	1.50	2.67
October	360.5	193	289	1.50	1.87	0.80
November	187.3	126	103	0.82	1.49	0.55
December	8.0	6	6	1.00	1.33	0.75
January 1955	7.0	3	1	0.33	2.33	0.14
February	21.0	11	8	0.73	1.91	0.38
March	No Effort	No Effort	0	0	0	0
April	No Effort	No Effort	0	0	0	0
May	No Effort	No Effort	0	0	0	0
June	No Effort	No Effort	0	0	0	0
July	No Effort	No Effort	0	0	0	0
August	No Effort	No Effort	0	0	0	0
Totals and Means	622.3	359	476	1.3	1.9	1.0

Average weight crappie caught: 0.73 pounds.

TABLE 37

Sport Catch
Directed Effort for Bream

Month	Total Hours Spent	Number Fishermen For Bream	Number Bream Caught	Average* Bream Per Fisherman	Average* Time Spent When Checked	Catch Per Man Hour
March 1954	52.4	20	101	5.05	2.62	1.93
April 1954	1132.2	475	2130	4.48	2.38	1.88
May 1954	1226.9	464	2279	4.91	2.64	1.86
June 1954	1471.1	740	3081	4.16	1.99	2.09
July 1954	1531.9	745	2966	3.98	2.05	1.94
Aug. 1954	711.3	470	1515	3.22	1.51	2.13
Sept. 1954	351.0	211	608	2.88	1.66	1.73
Oct. 1954	80.0	43	119	2.77	1.86	1.49
Nov. 1954	8.0	5	7	1.40	1.60	0.88
Dec. 1954	10.0	7	25	3.57	1.43	2.50
Jan. 1955	29.0	14	55	3.92	2.07	1.89
Feb. 1955	57.0	31	83	2.68	1.84	1.46
March 1955	33.0	24	35	1.46	1.38	1.06
April 1955	473.5	194	638	3.29	2.44	1.35
May 1955	397.5	179	696	3.89	2.22	1.75
June 1955	410.8	163	578	3.55	2.50	1.42
July 1955	306.2	146	616	4.22	2.10	2.01
Aug. 1955	291.3	119	412	3.46	2.45	1.41
Totals and Means	8573.1	4050	15,944	3.9	2.0	1.7

Average weight of Bream caught: 0.43 Lbs.

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A NEW CORIXID (HEMIPTERA) FROM GEORGIA [1, 2]

H. B. Hungerford and R. F. Hussey
University of Kansas
and
University of Florida

The first specimen of this species, a male, was collected by Dr. Lewis Berner, June 3, 1953, at Lewis Pond in Seminole County, Georgia. The junior author recognized it as a new species near *Sigara (Phaeosigara) mississippiensis* Hungerford. With it Dr. Berner collected numerous *Sigara (Phaeosigara) bradleyi* (Abbott) and a single *Trichocorixa minima* (Abbott).

On April 9, 1955, a series of 13 males and 19 females of the new species was taken at Lewis Pond by the junior author. A few *Hesperocorixa brimleyi* (Kirkaldy) were collected at the same time, together with one male and one female of *Sigara* (*Pileosigara*) *douglasensis* (Hungerford), a species known previously only from Minnesota, Michigan, Massachusetts, New Jersey, and Pennsylvania.

All of these specimens were taken from alga-choked seines as a by-product of collecting fish, and came from the water lily zone extending out some fifteen to twenty yards from the shore of the pond. Despite intensive efforts by the junior author and by Dr. M. J. Westfall, Jr., no specimens of the new species were collected with dip nets or with a Needham apron net on this second date. However, the junior author secured a single female in half an hour's collecting with a dip net at the same locality on June 2, 1955.

Lewis Pond is in the extreme southwestern corner of Georgia, about 13½ miles south and slightly east of Donalsonville, and about five miles west and south of Spring Creek. It lies in open fields, and is a shallow, kidney-shaped body of water perhaps 3,000 feet

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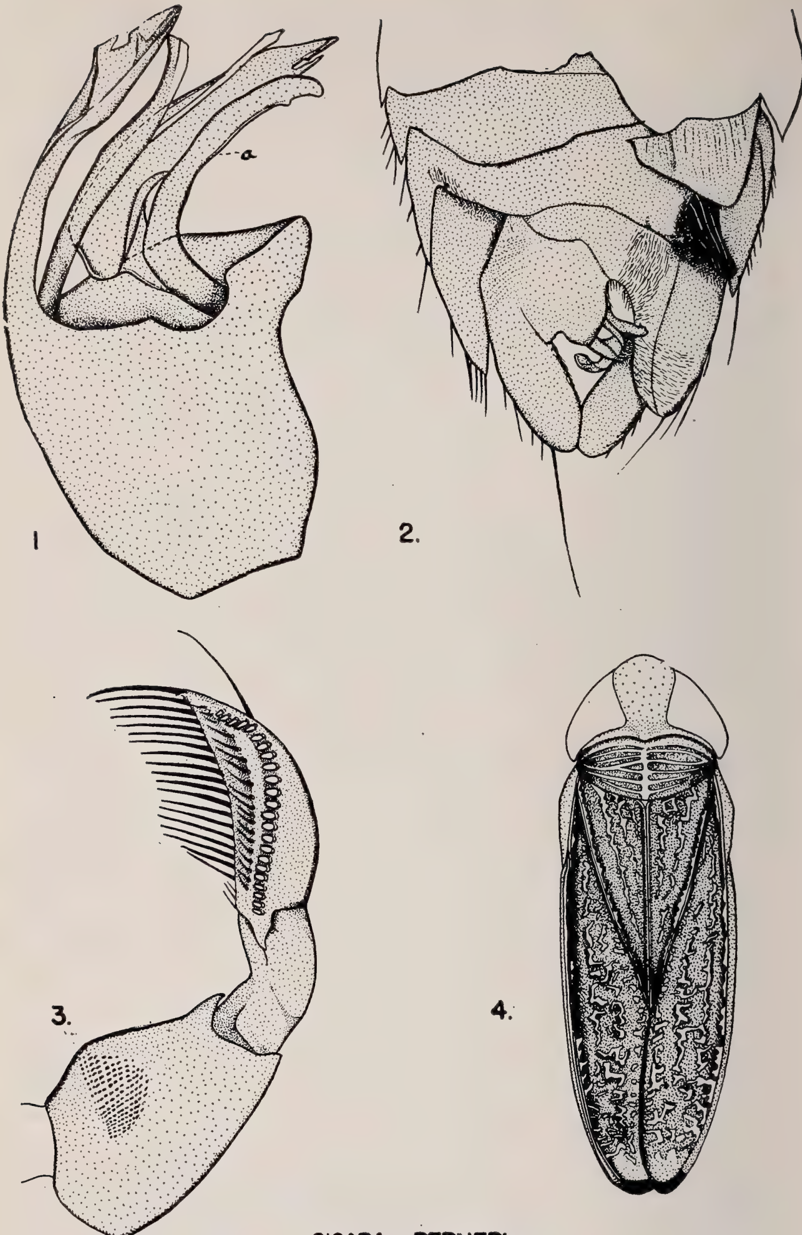
[1] This paper is based on materials collected during a biological survey of the region near the junction of the Flint and Chattahoochee Rivers, conducted by the Florida State Museum and the Department of Biology of the University of Florida under the auspices of the National Park Service in 1953-54, and continued since 1954 under a grant from the National Science Foundation. Additional funds have come from a separate grant to the senior author from the National Science Foundation.

[2] Contribution No. 960 from the Department of Entomology of the University of Kansas.



SIGARA BERNERI

Explanation of Figures

Sigara (Phaeosigara) berneri, new species

Fig. 1. Male genital capsule. *a*, right clasper.

Fig. 2. Dorsum of male abdomen, showing strigil.

Fig. 3. Right front leg of male.

Fig. 4. Dorsal view of male.

long in wet seasons. In the spring of 1955, after many months of prolonged dry weather, it was hardly half that size. This pond and Ray's Lake, its larger neighbor about half a mile to the northeast, are the two permanent bodies of water in the lower part of Fish Pond Drain, which traverses Seminole County roughly from north to south and opens into the Flint River a few miles below Lewis Pond. Upon completion of the Jim Woodruff dam at the junction of the Flint and Chattahoochee Rivers, the impounded waters will back up through Fish Pond Drain, and both Lewis Pond and Ray's Lake will be obliterated. Indeed, this may have taken place by the time this article appears in print.

SIGARA (PHAEOSIGARA) BERENRI, new species

Size: Length 4.4 mm. to 4.83 mm., width across eyes 1.4 mm. to 1.43 mm.; form rather slender.

Color: General aspect medium to dark brown. Pronotum crossed by five or six dark bands, usually wider than the intervening pale bands, interrupted at middle by a longitudinal pale stripe; claval suture pale, with a dark serrated band on clavus paralleling it; claval pattern elsewhere confused and variable, with the pale figures wavy, longitudinal, and more or less connected; pale figures on corium irregular, wavy, and arranged in three longitudinal series; figures on membrane transverse; membrane tipped with a broad, nearly black band; head pale to smoky; embolium, venter, and legs pale, except hind tarsus which often is vermillion.

Structural characteristics: Head about one-half longer than pronotum; interocular space about two-thirds as wide as rear margin of eye; vertex plainly produced in both sexes; fovea of male shallow and narrow. Pronotal disk very short, strongly rastrate. Hemelytra rugulose, with some rastrations on clavus, and with scattered pale hairs; nodal furrow difficult to distinguish in most specimens. Lateral lobe of prothorax elongate, with parallel sides and rounded apex. Mesoepimeron moderately broad, with ostiole a little nearer to its tip than to lateral bend. Metaxyphus short, much broader than long. Front leg of female of usual shape. Front leg of male as shown in Figure 3, femur with a stridular area, pala with a row of about 24 pegs. Male genital capsule as shown in Figure 1; dorsum of male abdomen with strigil as shown in Figure 2. Hind femur with a considerable number of small pegs, more or less in a row, on its dorsal surface.

Comparative notes: This species is closely related to *Sigara* (*Phaeosigara*) *mississippiensis* Hungerford, and has much the same color pattern. It differs from that species in having a shorter pronotum and a shorter metaxyphus, the surface of the pronotal disk and the hemelytra are rougher, the strigil of the male is longer, both the genital claspers of the male are differently shaped, and there are many pegs on the dorsal surface of the hind femur whereas none occur there in *S. mississippiensis.* The structural differences in the genital parts preclude consideration of this species as a brachypterous form of *Sigara mississippiensis.*

Location of types: Described from a series of 14 males and 20 females taken in Lewis Pond, Seminole County, Georgia. Holotype, allotype, and some paratypes in University of Florida Collections; other paratypes in University of Michigan Museum of Zoology, the Francis Huntington Snow collections of the University of Kansas, and the United States National Museum.

RESEARCH NOTE

A Seaball from Escambia County, Florida

Seaballs are aggregations of organic material, usually plants, presumably formed under wave conditions which tend to work the plant mass into a compact ball-like form. Although the physics of their formation is not well understood, seaballs have been reported from Europe and America, from fresh and salt water, and from Silurian deposits. They have been formed from many substances such as larch needles, Ruppia, Cladophora and fish bones. Only in a very few situations have they been found in abundance and then only locally. Croneis and Grubbs (1939) in describing silurian sea balls, give an excellent historical summary and a good list of references.

In 1951 Dr. Ruth Schornherst Breen brought the writer the seaball shown in the photograph. According to her notes, "The seaball was collected about mid-April 1951 about 3 miles east of the Casino at Pensacola Beach, Escambia County — on the gulf side of Santa Rosa Island". Dr. Harold Humm kindly took two photographs of the seaball in July 1951. It was hoped to make a detailed analysis of the composition of the ball at a later date. Unfortunately it was probably thrown out accidently during a biennial clean up of a "Glory Hole". At least, it has not been seen during the last three years and must be presumed lost.

From the photograph, the seaball is an ellipsoid about 9 inches in major axis and about 4.5 inches minor axis. It is a dense mass of plant stems and a few roots or rhizomes and several fragments of stems of larger marsh plants. There is a definite orientation of the stems along the major axis. *Thallasia* and *Diplanthera* appear to be the most abundant. From the composition it seems reasonable to infer that the ball was probably formed in a collection of debris

in shallow water close to shore. This is in accord with Essig's (1948) conjecture that Ruppia balls are likely formed by wave action along the shallow water line.

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F. C. W. Olson
Oceanographic Institute
Florida State University
Tallahassee

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ASCORBIC ACID AND OXYGEN CONSUMPTION IN HUMANS

PAUL J. COUGHLIN, M.D. AND
VERA O. PURLEE, B.S., M.T. (ASCP)
Research, Inc., Tallahassee, Fla.

INTRODUCTION

Ascorbic acid, as is well known, has the composition of $C_6 H_8 O_6$ and is a levorotatory lactone of tetraoxyketocapronic acid. It was first synthesized in crystalline form by A. Szent-Gyorgi about 1928 from vegetables and later from the adrenal cortex. Its distribution in the vegetable kingdom can be ascertained from any standard text on nutrition or biochemistry. In dry form it is stable, as are solutions in air free ampules. In solutions exposed to air, however, it is oxidized and is strongly reducing (Sollmann, 1937).

In humans the largest amounts exist in the adrenal cortex and corpus luteum; then, in order, come the brain and glandular tissues, pancreas, thymus in children, testes, ovary, kidney, spleen and lung. The normal range of fasting blood ascorbic acid level is considered to be 0.75 mgm. % to 3 mgm. % (Bodansky, Wroblewski and Markardt, 1952). The storage in the body is small, and decreases fairly rapidly if the diet is deficient. Not only does it decrease rapidly in mildly deficient diets, but in certain diseased states the demand and utilization is tremendous. Although *gross* scurvy occurs only after a *complete* deprivation of about *four* months, and is now rarely seen, subclinical avitaminosis C is common in our civilization. Morris (1954) showed a 5.45 percent incidence of all new adults in one year (1953) of his own private practice and Youmans (1941) states that a 30 to 40 percent deficiency occurs in patients who thought that they had an adequate diet.

One should not make the mistake of thinking only in terms of dietary intake when considering the possibility of avitaminosis C. The literature abounds with other factors. (a) Borden (1952) has described its reduction due to bacteria; (b) Roetzschmar and Ellis (1947) due to radiation and (c) Waldo and Zipf (1955) due to Acth and Cortisone; (d) Sayers (1948) due to stress; (e) Rinehart and Johnson (1944) due to rheumatic fever; (f) Coughlin (in press) with toxaemias; (g) Coughlin and Mickler (in press) in neurological viruses; (h) Selsman and Horoschak (1950) in hypertension.

It has been more than 30 years since Warburg (1925), in Germany first demonstrated his "Cell Respiratory Enzyme System".

Stewart, Leavmonth and Pollock (1941) suggested that ascorbic acid secures a more adequate supply of oxygen in the tissues in experiments, which prolong the life of cats after severe hemorrhage, by the intravenous administration of ascorbic acid. Peterson (1941) showed that similar results were obtained in mice subjected to low oxygen tensions.

Warburg (1925) has written:

> The oxidation system in the body is carried out by various dehydrogenases. Hydrogen is oxidized to water through the direct mediation of the cytochrome system between the dehydrogenase system on the one hand and molecular oxygen on the other.
>
> Dehydrogenation of a reduced compound of a *reversible* dehydrogenase system can take place only if there is also present another O-R system of higher, more positive potential, so that its oxidized component can accept hydrogen or electrons from the reduced form of the first system. The reaction of the two systems with each other is reversible, *and in the absence of disturbing factors* reaches an equilibrium.
>
> In this way, through the mediation of a series of O-R systems of gradually increasing potential, the equilibrium, above, is constantly shifted to the right and dehydrogenation progresses. Eventually the system represented by molecular oxygen, having a very high potential comes into play and the transfer of hydrogen ions and electrons from the metabolite to oxygen is completed by a virtually irreversible series of reactions in which all of the free energy of hydrogen is released.

The present study was undertaken with patients who had been afflicted with a neurotropic virus in Tallahassee, Fla. late in the fall of 1954. Although some of these patients exhibited some of the symptoms of frank scurvy, such as bleeding gums, diarrhea, bruising easily, joint pains etc., many of them did not. They all did exhibit fatigue, shortness of breath, irritability and a wide variety

of other symptoms including those of mental confusion, forgetfulness, etc.

The idea of a relationship between ascorbic acid and oxygen consumption in humans first presented itself when it was clinically noticed that: (a) many patients, who had difficulty in breathing on the basal metabolic machine, had low blood ascorbic acid levels. (b) Many patients who complained of fatigue, sensation of air hunger, and shortness of breath on exertion, also had low blood ascorbic acid levels.

Methods and Materials

Thirty eight patients were studied by having fasting blood ascorbic acid levels determined by the method of Emmerie and van Eckien (1934) and then measuring their basal oxygen consumption on a waterless metabolor basal metabolic rate machine for three minutes, then administering 250 mgm. of ascorbic acid intramuscularly. The three minutes oxygen consumption was then measured at fifteen and thirty minute intervals after injection. Originally thirty minute intervals were used. But as the study progressed, it was found necessary to use fifteen as well as thirty minute intervals.

In order to run a controlled comparison it was felt necessary to use placebos. In the beginning saline was used. As the study progressed, it was felt advisable to change to distilled water.

Remaining elements to be studied are the measuring of oxyhemoglobin response, and blood oxygen volume concentration to intramuscular ascorbic acid, as well as, urinary excretion of ascorbic acid in these patients.

Findings

The patients were divided into two groups. Those in whom fasting blood ascorbic acid levels are less than 0.4 mgm. percent are tabulated in Table 1. These will be referred to as Group I.

With the exception of four, apparently normal individuals, (No's 3, 7, 27, 33) the reminder, in spite of having signs and symptoms of subclinical scurvy, had blood ascorbic acid levels above 0.85 mgm. percent are tabulated in Table 2. These will be referred to as Group II.

In Group I, consisting of twenty patients, who had fasting blood ascorbic acid levels of from 0.0 mgm. percent to 0.2 mgm. percent,

TABLE 1

GROUP I

.4 to .8 Liters O_2 Following I. M. Injections of 250 mgm. Ascorbic Acid

No.	B.M.R.	$B.O_2$	After Cevalin 15 min.	After Cevalin 30 min.	Incr.	% Incr.	Placebo	T.T.	Oxy.	mgm. % Bl.A.A.
1.		0.4	0.8	Spring Stuck	0.4	50%	0.4	XXX		0.2
† 9.		0.8	—	1.3	0.5	62½%	0.8	XXX		0.0
11.		0.3	—	0.6	0.3	50%	0.3	XXX		0.0
12.		0.3	0.6	0.6	0.3	50%	0.3	XXXX	3.2 27%	0.2
* † 13.	—21	0.0	0.6	0.0	0.6	60%	0.1	XXX		0.0
14.	—26	0.3	—	0.8	0.5		0.5(S)	XXX	3.4 32%	0.0
16.		0.0	0.0	0.6	0.6		0.3(S)	XXX		0.2
* † 17.		0.0	0.6	0.0	0.6		0.0	XXX		0.0
† 18.		0.5	—	0.9	0.4		0.6	XXXX		0.0
21.		0.1	0.7	0.5	0.6		0.1	XXX		0.2

TABLE 1—Continued

GROUP I

.4 to .8 Liters O_2 Following I. M. Injections of 250 mgm. Ascorbic Acid

No.	B.M.R.	$B.O_2$	After Cevalin 15 min.	After Cevalin 30 min.	Incr.	% Incr.	Placebo	T.T.	Oxy.	mgm. % Bl.A.A.
* 22.		0.5	0.7	0.5	0.2		0.4	XX		0.4
* 23.		0.0	0.6	0.0	0.6		0.0	XXXX		0.0
* 24.		0.2	0.5	0.2	0.3		0.2	XX	2.9 23%	0.0
25.		0.2	0.7	0.7	0.5		0.3	XXXX	4.0 21%	0.0
28.		0.0	0.8	0.7	0.8		0.2(S)	XXXX	3.2 24%	0.0
* 29.	—40	0.3	0.7	0.3	0.4		0.2	XXXX	3.1 24%	0.0
* 30.		0.5	0.8	0.6	0.3		0.4	XXXX		0.0
35.		0.6	—	0.9	0.3		0.6	XXXX		0.0
† 36.	—38	0.0	0.0	0.5	0.5		0.0	XXXX		0.0
37.	—40	0.0	0.5	0.8	0.8		0.0	XXXX	6.2 37%	0.0

* Denotes patient showed greater response at 15 minutes than thirty.

TABLE 2

GROUP II

Patients with Less than 0.1 rise in O_2 after Injection with Ascorbic Acid

No.	B.M.R.	$B.O_2$	After Cevalin 15 min.	30 min.	Incr.	Placebo	T.T.	Oxy.	Bl.A.A.
2.		0.4	0.4	Spring Stuck	0.0	0.4	XX		1.0
* 3.		0.8	0.8	0.9	0.1		Neg.		1.4
4.		0.0	0.0	0.0	0.0		Neg.		1.2
5.	—5	0.5	0.4	0.5	0.0	0.5	XXXX		1.5
6.		0.6	0.4	0.4	—0.2		Neg.		1.0
* 7.		0.6	0.6	0.5	—0.1		Neg.		1.5
8.		0.7	0.6	0.6	0.0	0.6	XXXX		.92
10.		0.4	—	0.5	0.1		XX	5.8 46%	1.2
15.		0.7	0.7	0.7	0.0		XXX		
19.		0.4	—	0.2	—0.2	0.4	XXX		3.0
20.		1.0	—	0.6	—0.4	1.0			1.75
26.	—21	0.6	0.7	0.7	0.1		XX	5.6 38.5%	0.85
* 27.		0.8	0.8	0.7	—0.1		Neg.	7.5 53%	1.00
31.	—15	0.45	0.6	0.5	0.15	0.4			1.3
32.		0.7	0.6	0.6	—0.0	0.6	XXX		Qns.
* 33.		0.8	—	0.7	—0.1		Neg.		1.2
34.		0.4	0.5	0.5	0.1	0.4		2.9 29%	1.2

* Denotes apparently normal individuals.

there was an increased three minute oxygen consumption from 0.3 liters to 0.8 liters, fifteen to thirty minutes after the injection of 250 mgm. of ascorbic acid. The greatest increase (0.6 to 0.8) came in those patients who had the lowest basal oxygen consumption (No's 13, 16, 17, 21, 28, 37). One patient (No. 22) had a lower three minute oxygen consumption response (.2 liter) and a higher ascorbic acid level (0.4 mgm. percent) than the others.

Seven of the patients, marked with an asterisk in Table I, showed a greater response at fifteen minutes than thirty, with six of them showing the same consumption at thirty minutes time as their basal oxygen level. This suggests that in many patients the rate of utilization of ascorbic acid is much faster than others.

It is interesting to note that six patients (No's 9, 13, 17, 18, 36, 37) with proven past histories of rheumatic fever have fasting ascorbic acid levels of 0.0 mgm. percent and are among those with higher oxygen consumption response to intramuscular ascorbic acid.

It should be noted that four (No's 9, 13, 17, 24) of these patients were taking 1000 mgm. of ascorbic acid orally, daily, at the time the tests were run. One patient (No. 17), who not only had rheumatic fever, but Sydenham's chorea as a child; in addition to what is here recorded, had three fasting blood levels of 0.0 mgms. at a teaching facility, where he is now being studied further, and it has there been determined that he requires daily dosage of 2500 mgm. orally to maintain a fasting level of 0.4 mgm. percent.

The three minute oxygen consumption on placebo of distilled water was identical with the basal oxygen consumption except that in three cases (No's 13, 18, 25) there was a negligible increase of 0.1 liter and in three (No's 22, 29, 30) there was a decrease of 0.1 liter.

In the three cases (No's 14, 16, 28), where saline was used as a placebo, the increase was .2 liter to .3 liter. This suggests that even small amounts of saline may have an effect on oxygen consumption or ascorbic acid utilization. Although four had basal metabolic rates of —21 to —40, their protein-bound-iodines were within normal limits. Thus again demonstrating that the basal metabolic rate is not a test of thyroid function *per se,* but only a test of oxygen consumption. All of the patients in Group I had positive tourniquet tests. The random checking of oxyhemoglobins in this group demonstrated five had percentages of oxygen saturation in the range of 20 percent to 30 percent and two in the range of 30 percent to

40 percent. While at the same time these same patients had hemoglobins (acid hematin) well within the limits of normal, ranging from 13.7 gms. to 17.4 grams.

In Group II, consisting of 17 patients with fasting blood ascorbic acid levels, on venous blood drawn from the anticubital vein, ranging from .85 mgm. percent to 3.0 mgms. percent, the highest three minute oxygen consumption, fifteen to thirty minutes after intramuscular injection with 250 mgm. of ascorbic acid was 0.15 liter and in many cases (No's 6, 7, 19, 20, 32, 33) there was a decrease. The reason for this cannot be explained at the present time.

It should be noticed that in this group, with one exception, the lowest three minute basal oxygen consumption was 0.4 liter. This is contrasted with Group I in which only six had 0.4 liter or over. In the one case (No. 4) of 0.0 liter basal and three minute consumption, the patient had a reaction to ascorbic acid by mouth.

The placebo of distilled water showed comparable results to Group I.

The four (No's 3, 7, 27, 33) apparently normal individuals not only had fasting blood ascorbic acid levels above 1.0 mgm. percent, but had no increase in oxygen consumption after injection and negative tourniquet tests.

The random oxyhemoglobin tests in Group II, although too few to be statistically significant, in general reveal a higher range (38.5 percent to 53 percent) than in Group I. More detailed work on this factor is being studied at present.

Summary and Conclusions

There is presented two groups of patients exhibiting signs and symptoms of subclinical scurvy and five apparently normal subjects. One, in which the fasting blood ascorbic acid level is below 0.4 mgm. percent and the other in which the blood ascorbic acid levels are above 0.85 mgm. percent.

In Group I the response of increased oxygen consumption, after intramuscular administration of 250 mgm. ascorbic acid, is in the range of 0.4 liter to 0.8 liter for three minutes after fifteen to thirty minute intervals and in Group II the increased oxygen consumption, using the same technique, is of the range of 0.0 liter to 0.15 liter.

With the exception of the five apparently normal individuals, the remainder of Group II exhibit signs and symptoms of subclinical

scurvy in spite of the fact that their blood ascorbic acid levels are of the magnitude of 0.85 mgm. percent to 3.0 mgms. percent. This clearly demonstrates that there are factors concerned with this condition other than ascorbic acid alone.

It has been shown in these studies oxygen consumption is definitely dependent upon ascorbic acid, if not as a major factor, certainly a very important one in cellular respiration. The use of the basal metabolic machine must not be confined, in our thinking, to the thyroid gland as a test of thyroid function exclusively, but has a definite value in measuring oxygen response to various oxygenating catalysts or enzymes such as ascorbic acid, thiamine, niacin, B_{12}, possibly pyridoxine and others (Warburg, 1925; Stewart, Leavmonth, and Pollock, 1941).

The rate of utilization of ascorbic acid varies tremendously. As exemplified by patients (No's 13, 17, 22, 23, 24, 29, 30), ascorbic acid is much more rapidly used than in the rest of the group.

Hypovitaminosis C is not only an entity within itself, but plays a definite role in many disease entities. Many more patients are subclinically deficient in ascorbic acid than has previously been recognized. We can no longer think of hypovitaminosis C in terms of classical "scurvy" but rather, must look for the subclinical manifestations and test by tourniquet test, oxyhemoglobin and blood ascorbic acid levels and oxygen consumption for the presence of such conditions.

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NOTES ON FOSSIL CROCODILIANS FROM SOUTHEASTERN UNITED STATES [1]

WALTER AUFFENBERG
University of Florida

The Tertiary and Pleistocene strata of southeastern United States are fairly rich in crocodilian remains. For the most part, these fossils have received but little attention in the past. Material examined or collected during the past few years has provided additional information on these animals in this area, and the new data seem worthy of publication.

The paleontological collections of the Florida Geological Survey contain remains of crocodilians from the deposits of Griscom Plantation, Leon County, and Midway, Gadsden County, Florida. These localities are considered Lower Miocene (Wood, *et al.,* 1941). *Alligator olseni* White has been previously reported from only the type locality: Thomas Farm, Gilchrist County, Florida, Lower Miocene. It is thus of interest that the Griscom and Midway deposits also contain remains of an alligatorid crocodilian, here referred to the same species.

From Midway only a few small dorsal plates are available (FGS V-3513, 4186). They are identical to those found at the type locality.

Considerably more material is available from the Griscom Plantation, including several dorsal plates (FGS V-3785a and b, V-1440 and V-1439), some fragmentary vertebrae (FGS V-1437-8 and V-2777) and some badly broken cranial elements. The latter include a lacrimal (FGS V-2768), a broken maxillary (FGS V-1436) and a partial premaxillary (FGS V-1436). None are particularly diagnostic, with the exception of the premaxillary, which is briefly described below.

The element is provided with alveoli for four teeth. The first tooth is missing. The second is represented by a small partial alveolus. Medio-posterior to this is a large pit for the reception of a mandibular tooth. The third and fourth alveoli are large. The fifth is smaller, about the same size as that for the second tooth. Between the large alveoli of the third and fourth teeth, and directly

[1] A Contribution from the Biology Department and the Florida State Museum.

behind the first large pit, is a small pit. This is followed by one which is slightly larger, on a level between the fourth and fifth alveoli. A very large pit is present on the premaxillary-maxillary sutural line.

Dorsally a small portion of the narial opening is present. Postero-laterally the opening is bordered by a low rounded ridge.

The distribution and size of the pits and alveoli, as well as the absence of a premaxillary-maxillary notch, indicate that this element probably represents an alligator, rather than a true crocodile. A comparison of this, and the other fragments mentioned above, with the holotype and the other available specimens of *Alligator olseni* from the type locality, shows the closest possible agreement.

The nasal septum in the holotype of *A. olseni* is not entirely preserved. However, White (1942) stated that he believed the septum was complete in this species. There is no doubt of this now, since subsequently specimens collected, maintained in the collections of the Museum of Comparative Zoology, all have the septum completely preserved.

Considerably more important are certain observations on the extinct crocodile, *Gavialosuchus americanus*. Material has been collected from several new localities in Florida. Of particular interest is the discovery of a partial skull from South Carolina.

The generic status of *Gavialosuchus* Toula and Kail, has suffered considerable vacillation through the years. Many workers have preferred to synonomize this genus with *Tomistoma* Müller. The most recent of these is Müller (1927).

Mook (1920, 1924) recognized the genus *Gavialosuchus* mainly on the basis of a subtriangular, rather than a circular internal narial opening. This character exhibits at least some variation in the available skulls of *G. americanus* (Auffenberg, 1954). The shape of the opening is also variable in several modern genera; both ontogenetic and individual variation having been observed. The character thus loses considerable diagnostic value, and it is largely on this basis that Müller objected to the retention of the name as a valid genus.

However, at least one character clearly separates *Tomistoma* from *Gavialosuchus* on the basis of the available material. This concerns the presence or absence of a keel on the plates making up the dorsal armor.

A median keel is present in the middle thoracic dorsal plates of all modern crocodilians, including *Tomistoma.* Almost two hundred plates of *Gavialosuchus americanus* are now available, none of which possess a median keel. Approximately fifty plates have been collected along with a nearly completely articulated skeleton of this form from a deposit near Haile, Alachua County, Florida (Auffenberg, 1954). None of the plates possess any median keels. Several fossil genera are known in which the plates lack this structure. De Vis (1885) has described plates from *Pallimnarchus pollens,* a Pleistocene crocodile from Australia, which are very similar to those found in association with *G. americanus.* However, armor of this type constituted only a small percentage of the total number secured from the same deposit. Forty per cent of the plates of *Pallimnarchus* were distinctly keeled. De Vis thus assumed that the un-keeled members belong to the abdominal series. This may be true; but the total absence of *any* keeled plates in association with *Gavialosuchus americanus* suggests that a keel is lacking in all of the plates in this form.

As far as is known, *Gavialosuchus* is the only crocodilian from southeastern United States in which keeled plates are absent. Until other Tertiary crocodilians are found in this area which also lack these structures, the occurrence of plates of this type in any Tertiary deposit in this area would seem to suggest the presence of this, or some very closely related form.

A small un-keeled fragmental plate, provisionally referred to *G. americanus,* has been found in a small brook flowing over the Hawthorne formation in the western part of the campus of the University of Florida, Gainesville. A similar but larger and better preserved plate (UF 3395) has been collected from the bed of the stream formed by Glen Springs, in the northwestern part of Gainesville, Alachua County, Florida (R20E, T93, Sec. 30). Associated with the piece were teeth of the extinct shark, *Hemipristis,* various rib fragments of a sirenian and a last molar of the extinct dugong, *Felsinotherium.* The deposit is Upper Miocene, Hawthorne formation (Pirkle, 1956).

The fact that UF 3395 originates from an Upper Miocene deposit, and that the type locality of the species, the Bone Valley formation of central Florida, is now considered as representing the same period (Olsen, 1956; Vernon, 1951; etc.), suggests that the completely articulated specimen from Haile, Locality VI, Alachua

County, (Auffenberg, 1954) also represents this period. The genus should definitely be listed among the Miocene vertebrates of Florida, and included the Pliocene fauna only with reservation.

Considerably more important is the discovery of this species of crocodile in South Carolina. The available material consists of a partial skull (ChM 13745) and two dorsal plates (ChM 13942 and 35.208.176) in the Charleston Museum, Charleston, South Carolina.

Number 13942 is part of the old collection of that museum, and the datum is simply "South Carolina Phosphate Beds". Number 35.208.176 was collected at Edisto Beach, Charleston County. Both the phosphate beds and Edisto Beach are known to contain Miocene, Pliocene (?) and Pleistocene vertebrates. The Miocene forms are all marine species. The Pleistocene fauna contains both terrestrial and marine vertebrates. The Pliocene fauna, if present at all, is almost entirely unknown. Both of the plates lack the median keel, and are identical to those collected from various localities in Florida.

The skull was collected during phosphate excavations near Lambs, Charleston County. The surrounding matrix is typical of the phosphate-bearing strata of Charleston County; generally thought to represent the Upper (?) Miocene, although possibly reworked (at least in part) during the Pleistocene.

The skull is crushed from above and slightly from behind. It includes the anterior edge of the right orbit, including the very anterior portion of the quadrato-jugal, the right lacrimal, right prefrontal, part of the nasals and a fair portion of the maxillary. There are five maxillary teeth on the right side. The right palatal fenestra is present. It is of the same shape as that in the skulls in the American Museum of Natural History Collection (AMNH 1651 and AMNH 5663). It is proportionately longer than in UF 6225; although the latter was somewhat crushed in this general area, so that the slight difference in length may not be significant. There are five teeth on the right side, all of which are almost completely smooth and non-ribbed, as those in the other available skulls of *Gavialosuchus americanus*. A number of alveoli are also present on the same side. The last tooth in UF 6225 is the nineteenth. Assuming the same number of teeth in the Charleston skull, the fragment extends anteriorly to the eleventh alveolus. The larger of the available teeth would thus represent numbers fourteen and fifteen, as in UF 6225. The palatines extend forward for a dis-

tance of three teeth from the palatal fenestra, as in UF 6225 and AMNH 5663.

There is little reason to believe that the Charleston Museum skull represents a form other than *G. americanus.* This specimen thus extends the known range of the species considerably northward of that previously proposed. Miocene marine deposits west of peninsula Florida should yield additional remains of this interesting crocodilian.

Isolated fragmental skull and mandibular teeth, as well as plates of the dorsal armor of *G. americanus* in several collections, indicate that this crocodilian grew to a very large size. Some of the plates exceed eleven centimeters. Assuming these to be the largest of the dorsal series, there is every reason to believe that the species attained lengths in excess of thirty feet.

A single fragmentary maxillary in the collections of the Charleston Museum (ChM 41.188.45; "Phosphate Beds, South Carolina") is very interesting in that it is provided with a single tooth which is strongly ribbed. The tooth is approximately ten millimeters long, and thus considerably smaller than those in the available skulls of *G. americanus.* The shape of the maxillary suggests that of *Gavialosuchus;* i.e.: a long, narrow snouted crocodilian. Strongly ribbed teeth occur only in *Crocodilus cataphractus* among Recent forms, although many fossils forms are known to have possessed them.

Ribbing is somewhat variable, even within the same species (Mook, 1931). It is not, however, a character associated with age, since smaller specimens of *Gavialosuchus americanus* have almost completely smooth teeth, as do the adults. Furthermore, some ribbed teeth available from other areas are as large, if not larger than many of those of *G. americanus.* Newly replaced teeth of *G. americanus* are also smooth.

Ribbed crocodilian teeth occur in the Bone Valley formation of Florida, as for example, in FGS V-4993, a posterior tooth in which plications are found at the base. More important, a number of fossil crocodiles have been described from Tertiary (?) deposits of the central eastern seaboard. Some of these, like *Pliogonodon priscus* Leidy, are provided with ribbed teeth. The relationships of the southeastern crocodiles possessing teeth of this type to species from the central Atlantic states are completely unknown. Until the fossil crocodilians of New Jersey and Maryland are studied in

some detail, it will be impossible to assign the unusual South Carolina and Florida specimens to a particular genus or species.

The skull and dorsal plates of *Holops* Cope, a form known from the Cretaceous and Eocene, are very similar to those in *Gavialosuchus*. The teeth of the two genera are also very close. The relationships of these genera should be investigated. Several of the long-snouted European Tertiary crocodilians, such as *Crocodilus toliapicus, C. arduini* and *C. champsoides* should be re-examined in the light of more recent information on *Gavialosuchus*. Other than the characters mentioned above, attention should also be drawn to the shape of the prefronto-frontal suture, which is less angular and more rounded in *Holops, Gavialosuchus, Crocodilus toliapicus, C. arduini* and *C. champsoides* than it is in any other recent or fossil long-snouted crocodilian, with the possible exception of *Crocodilus cataphractus*. *Crocodilus champsoides* may be close to *C. cataphractus*. The similarity in morphology of all of these forms, even though slight, should be examined to determine possible relationships or parallel evolutionary trends.

Although many fossil crocodilians have been described, their relationships to one another are far from being understood. We know almost nothing concerning the ancestry of our Recent crocodilians though phyletic lines culminating in these forms should be at least partially represented in the fossils already available. It has been only relatively recently that serious attention has been drawn to many un-studied collections of Cenozoic reptiles and amphibians. As interest in this field continues to develop, it is hoped that phyletic lines of Recent forms will become established. This need is as great in the study of the crocodilians as it is in the urodeles, salientians and snakes.

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FLORIDA WATERSHEDS UNDER PUBLIC LAW 566 [1, 2]

L. Orlando Roland
Soil Conservation Service
Gainesville, Florida

The sun and water drenched Genozoic Peninsula of Florida is a good example of the wonder and beauty of nature. It is likewise an outstanding example of the strong forces of water, wind, and soil which constantly challenge man's efforts to subdue them. The Florida Peninsula is a land which endures extremes of sun, water, wind, drought, as well as flood and evaporation. These are recurring experiences for its inhabitants.

Many years ago some of the more progressive people thought that man could and should do something to check, retard, and control the devastating effects of water upon our natural soil resources. Human nature is slow, it seems, to adopt changes which may affect old ways of doing things. In 1933 the Soil Erosion Service in the Department of the Interior was established. In 1935, Public Law 46 made this Service the Soil Conservation Service in the Department of Agriculture. In 1936 the Flood Control Act was passed to provide for projects of the large river basin type. Responsibility for upstream flood control was assigned to the Department of Agriculture. The real community of interest for the development of soil and water rsources is found in the small watershed.

Prior to the passage of the Watershed Protection and Flood Prevention Act (P.L. 566), the conservation program was concentrated on the two extremes. At one extreme under the Flood Control Act works had been authorized on eleven watersheds of the large basin type scattered from New York to Georgia and California and comprising over 30 million acres.

At the other extreme the Soil Conservation Service working with individual farmers and ranchers through the Soil Conservation Districts is helping solve the water and soil problems on farms and ranches. Soil and water problems were being attacked from the two points. The basin type approach dealt primarily with large reservoirs and the control of major stream problems. The Soil Con-

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[1] Presented at: Florida Academy of Sciences, University of Tampa, Tampa, Florida, December 1, 1956.

[2] Cleared by: Director, Division of Information, Soil Conservation Service, Washington 25, D. C.

servation Districts deal with the smallest operating unit in an effort to help the individual solve his soil and water problems. There was no program to deal with the middle groups, and the people in these categories were asking, "What can be done to solve our problems?" In order to reach these people and deal with their conservation problems, Public Law 566 was passed by the 83rd Congress in 1954. The scope of the Act was broadened and a number of its provisions were substantially changed by Public Law 1018 which the President signed August 7, 1956. The Watershed Protection and Flood Prevention Acts provide for a project-type approach to soil-and-water resource development, use, and conservation.

The major objective of the Watershed Protection and Flood Prevention Acts is to aid local groups of people in solving their flood prevention and water management problems in small watersheds. A watershed may range in size from a few hundred acres up to 250,000 acres. The Act authorized the Department of Agriculture to assist state and local agencies in carrying out jointly planned and mutually agreed upon flood-prevention and water-managemnt projects. It places responsibility on local organizations to initiate projects, adapt plans to local requirements, bear a fair share of the costs, and make provisions for operation and maintenance. The Act created the machinery under which the Federal Government can cooperate with local organizations in planning and carrying out measures for flood prevention and various phases for the conservation, utilization, and disposal of water. This is a plan for the people, by the people, and not a Federal project.

In order to complete a plan, there are four distinct phases; to state them briefly and in order of their occurrence, they are: the application, planning, installation and construction, and operation and maintenance. As the project develops all four phases become the responsibility of the local organization.

The local organization must have legal authority from the state to carry out, operate, and maintain the needed works of improvement for watershed conservation and flood prevention. The Governor or a state agency designated by him processes applications for Federal assistance.

During the planning stages, the problems as set forth by the interested group are investigated and checked along the lines of engineering, hydrology, geology, and economics. The benefit-cost ratio must show that the benefits from the project exceeds the costs.

Here in Florida the Lake Placid East Chain of Lakes Watershed Work Plan in Highlands County, which gave a benefit-cost comparison of 4.7 to 1, is now in the installation and construction phase. Work plans for the Taylor Creek Watershed in Okeechobee County and the Fisheating Creek Watershed in Highlands County are practically completed. Two more applications, Orange Lake Watershed in Alachua and Marion Counties, and Palatlakha Watershed in Lake County, have been approved for planning and considerable work has been done on the Orange Lake Plan. Other applications are on hand for review and study prior to authorization for planning. The size of these watersheds ranges from 12,500 acres to a little over 200,000 acres. Normally months are required to complete the planning phase for a watershed. The actual construction and installation of needed remedial measures may require from two to five years or longer to complete.

The local organization prepares a work plan with assistance from the Soil Conservation Service and other agencies. The plan describes the proposed measures, how they will be financed, and provides a time table as to when the measures will be installed and the project completed. The plan is signed by the local organization and sent to the Soil Conservation Service Administrator for review and recommendations. In some watersheds, the planning studies may show that a feasible project cannot be developed, or that the project should be postponed. Planning will be stopped or deferred if either the Service or the local organization concludes after a full hearing that an effective project cannot be developed at this time, or planning will be halted if your local organization decides for any reason to delay or abandon the project. The information required on each watershed varies according to the physical makeup of the surface as well as the subsurface conditions. The current study of the Orange Lake Watershed bears this out. (Figure 1.)

One of the outstanding problems in the Orange Lake Watershed is the recent low water in Orange Lake. The water in Orange Lake in August, 1956, was about eight feet lower than normal while Lake Newnan, seven miles north, was only about two feet below normal. Lake Newnan drains into Orange Lake. If the lake bottoms and surroundings were equal, Lake Newnan should be the one to show the greater water decline during extended dry periods because it is higher in the watershed and receives less water. As this is not the case, there must be a geologic reason for the difference. So far as

I have been able to determine Lake Newnan is entirely surrounded by Hawthorn formation of Miocene Age which is composed of interbedded sand, clay, marl, and limestone with lenses of Fuller's earth. Apparently this material has formed a rather impervious layer for the lake sides and bottom.

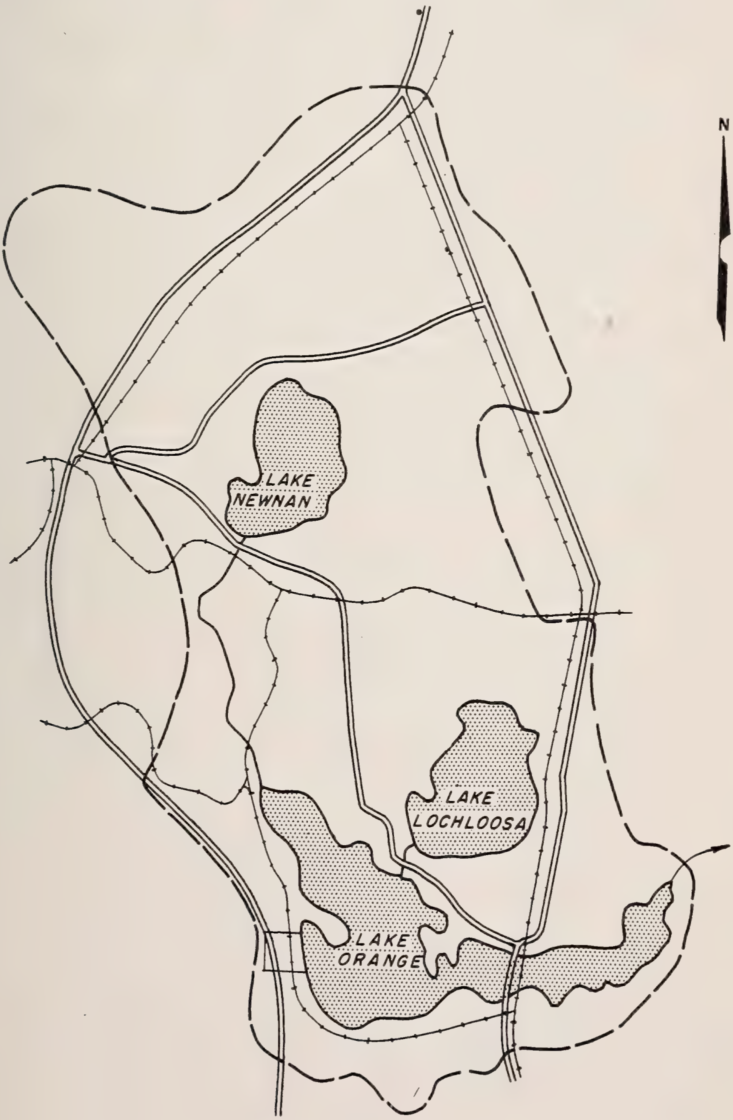

Figure 1. Orange Lake Watershed, 210,000 Acres.

Orange Lake does not fall into this same category because there is an outcrop of Ocala limestone exposed on the southwestern side of the lake. The Ocala limestone is porous and cavernous of Eocene Age. The surface exposure of the Ocala limestone in Orange Lake is about 200 feet wide. A sink roughly 200 feet across and 70 ± feet deep has developed along the edge and bottom of the lake in this formation. The date of this development is unknown. Limestone sinks are constantly increasing in size as water passes through them. The calcium carbonate and other solubles are dissolved and carried away in solution. There is every reason to believe that the Orange Lake sink is gradually getting larger. At present the sink is capable of taking several hundred cubic feet of water per minute. This, no doubt, has played a major role in lowering the water level in Orange Lake. When the lake level was at its lowest 50.06 Mean Sea Level August, 1956, the water level in the sink was 46.30 Mean Sea Level (U. S. Geological Survey) and there were indications of downward movement of water because the water in the sink was constantly swirling as it was being supplied by a stream which extended to the lake. Water in nearby deep wells showed the Piezometric table to be approximately 44 Mean Sea Level. This places the permanent water table only a few feet below the bottom of the present lake.

Let us assume a dam could be built across the lower end of Orange Lake to try to maintain a given lake level. Unless remedial measures are taken to isolate the sink, the success of this phase of the project would be highly questionable.

Holes about 50 feet apart were bored with a soil auger in a semicircle around the outer edge of the sink to determine the kind of material present. The first eight feet were composed of peat and muck, the next eighteen inches graded from muck to organics and silts. Below this layer is sandy clay to an indefinite depth. All of the data gathered indicate the underlying material is impermeable and that a good cutoff seal can be had by extending the clay core of a dam into the sandy clay stratum.

The sink is serving as a recharge area for the Ocala acquifer, and for that reason it should not be sealed by filling. It now appears that the best solution to this problem is to build a dike around the sink. (Figure 2.) Adequate outlets may need to be installed so that a part of the surplus water from the lake could be diverted into the sink acquifer for further use in wells and springs.

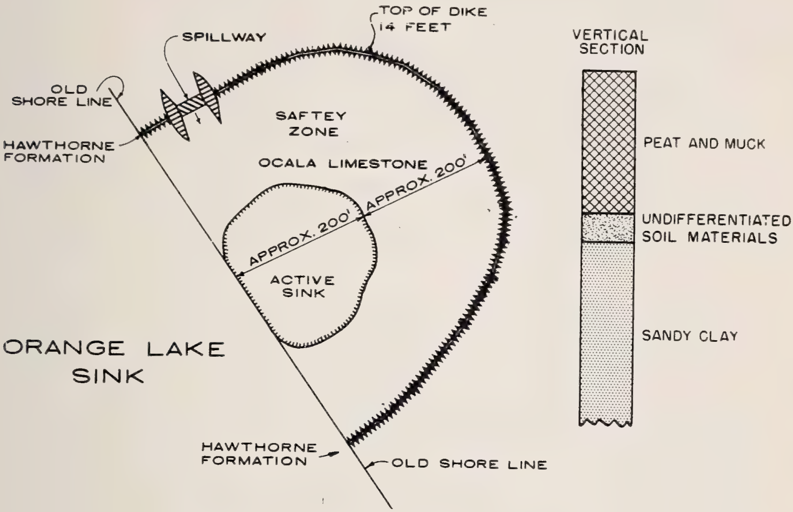

Figure 2.

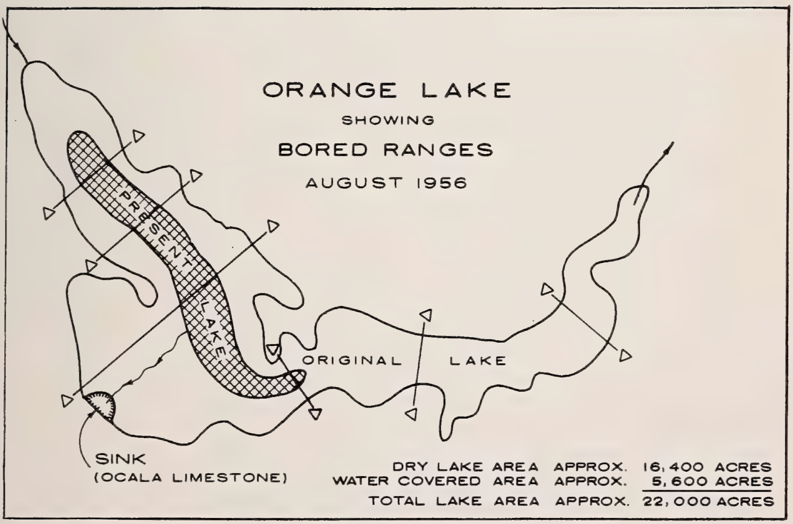

Figure 3.

At one time there were approximately two acres of open water in the sink. As the lake level receded and the lake area surrounding the sink dried up, a channel developed which allowed water to flow from the shrinking lake into the sink. The open water in the sink began to decrease as organic sludge was brought by the flowing stream. This process continued until the sink was filled with organics except for an area of about 1500 square feet. It seems that the channel across the dry lake to the sink delivers enough water to keep the sink hole open. There was a constant slow swirling effect in the open sink as the water passed down into the Ocala limestone.

Further checks are being made around the lake to see if there are other exposures of the Ocala limestone or permeable material which could allow the water to pass from the lake into the ground water table. Six sections across the lake were bored to determine the kind of material on the lake bottom. (Figure 3.) At the time the borings were made approximately four fifths of the lake area was dry. The deepest water found was four feet. There was one to two feet of organic sludge on the bottom. Underneath the sludge and organics was sandy clay, sandy clay loam, or clay. In every place examined, the substratum was impervious enough to prevent appreciable water losses through the bottom of the lake.

I have pointed out a few of the geologic problems of Orange Lake Watershed. There are major problems in engineering, hydrology, and economics as well as soil and vegetative cover which must be worked out and combined with the geologic conditions before we will be able to complete a plan and make a benefit-cost ratio comparison. Further studies and investigations must be carried out before a definite decision can be reached.

Quart. Journ. Fla. Acad. Sci., 20(2), 1957.

AN EMENDED DESCRIPTION OF THE MARINE NEMATODE *GENUS HALENCHUS* COBB, 1933 (TYLENCHINAE)*

A. C. TARJAN
Citrus Experiment Station
University of Florida

The genus *Halenchus* was erected by Cobb (1933) to receive *Tylenchus fucicola* de Man and Barton in de Man, 1892 (=*Halenchus fucicola* (de Man and Barton in de Man, 1892) Cobb, 1933) and *Tylenchus mediterraneus* Micoletzky, 1922 (=*Halenchus mediterranea* (Micoletzky, 1922) Cobb, 1933). Designating the former species as type, Cobb proposed the following generic diagnosis:

> "Tylenchidae (Tylenchinae). With the characters of Tylenchus but with the oesophageal bulbs vestigial, the junction of oesophagus and intestine more or less indefinite, and the terminus of the tail hooked towards ventral side. Differs from *Neotylenchus* in latter two characters and in that the lip region is divided into six instead of eight sectors. Differs from *Hexatylus* in having three and not six bulbs at base of spear. Spear smaller in male. Differs from all three also in being marine."

These characters for the genus *Halenchus* are not at variance with de Man's account for the type species (1892); however, it is felt that they are not sufficient for an adequate generic diagnosis. Cobb's description was based essentially on de Man's account of *T. fucicola* since Micoletzky, in his description of *T. mediterraneus,* admitted that his species very closely resembled *T. fucicola* and emphasized only what he regarded as specific differences.

De Man, in his description of the esophagus of *T. fucicola,* emphasized the lack of definite form of the metacorpus (Fig. 1, C) in his statement "Abweichend von den anderen Tylenchen bildet der Oesophagus also nicht einen mehr oder weniger scharf begrenzten und abgesetzten, vorderen Bulbus . . . " Micoletzky's failure to describe the metacorpus of *T. mediterraneus* suggests that his observations paralleled de Man's with respect to this part of the body. De Man's description of *T. fucicola* referred to the above mentioned metacorpal area as having a "Verdickung des Oesophagus resp. die Erweiterung des Chitinrohres" (Fig. 1, B). He con-

* Florida Agricultural Experiment Station Journal Series, No. 626.

tinued, "Hinter dem letzteren schwillt das Hinterende des Oesophagus, wie gewöhnlich, taschenartig an, und man beobachtet darin einen rundlichen Kern, der 8 - 8.5μ breit ist, mit 3μ breitem Nucleolus." In support of this statement, he figured the posterior part of the esophagus as overlapping the intestine (Fig. 1, D). Cobb (1933) erroneously believed both "bulbs" of the esophagus to be vestigial. A more stringent interpretation of de Man's account would suggest that the metacorpus is indistinct, but possesses a sclerotized portion in lieu of valves (Fig. 1, B) while the posterior portion of the esophagus lies free in the body, overlapping the intestine.

As stated previously, Micoletzky (1922) felt that his *T. mediterraneus* closely resembled *T. fucicola* and that "*T. mediterraneus* ist vermutlich die freilebende Stammart von *T. fucicola.*" He noted three major specific differences between *T. mediterraneus* and *T. fucicola*:

(1) The stylet of the former was 1/8 - 1/9th of the total esophageal length, while the stylet of the latter was 1/13 - 1/15th of the esophageal length.

(2) The postanal parts of the caudal alae for the former were less than 1/4th of the tail length, while those for the latter were more than 1/4th of the tail length.

(3) Both species came from different habitats.

Micoletzky then presented some minor differences in measurements of the two species. In his paper on *T. fucicola,* de Man pointed out that the total esophageal length varies; since the stylet length of both species is fairly constant at 17 - 18μ, Micoletzky's first point must be repudiated as a valid difference between species. His further contention that differences in the length of the postanal part of the caudal alae in relation to the total tail length represent specific differences should likewise be questioned in view of the work of Inglis (1954) on allometric growth in nematodes, as well as the author's personal observations on differences in size of specific structures between different populations of a given nematode species. The work of Goodey (1952) and Stephenson (1942) likewise necessitates a cautious attitude toward what constitutes a specific difference when different cultural media are involved. The foregoing considerations imply that *T. mediterraneus* is conspecific with *T. fucicola* and accordingly, a synonym of the latter species. Final adjudgment, however, should be made preferably after suitable

scrutiny of the type material of these two species. The inaccessibility of such material thus prohibits the synonymizing of these species at this time.

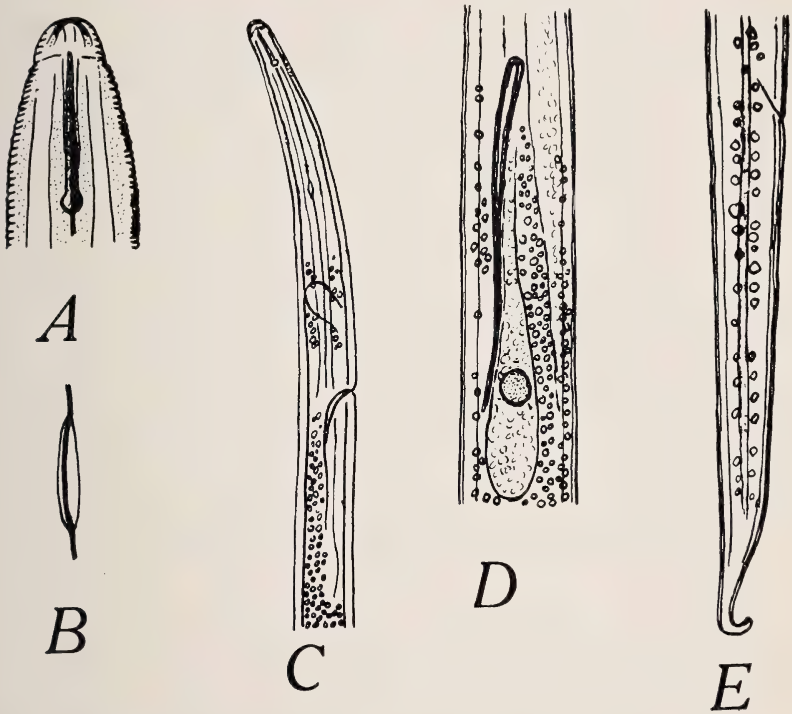

Figure 1. *Tylenchus fucicola* de Man and Barton in de Man, 1892. A. Head end of an adult female, lateral view, X 1300. B. The widening of the inner sclerotized tube in the anterior part of the esophagus of a female, X 1300. C. Anterior portion of a gravid, adult female, X 368. D. Portion of the esophagus posterior to the excretory pore of an adult female in a ventral poition. E. Tail of a female 1.26 mm. long, lateral view, X 650 (after de Man).

Two additional species of the genus *Halenchus* were established by Chitwood (1951), who redesignated *Tylenchus* (Chitinotylenchus) *zostericola* Allgen, 1934, as *Halenchus zostericola* (Allgen, 1934) Chitwood, 1951, and described a new species *Halenchus mexicanus* Chitwood, 1951. An inspection of the description and figures of Allgen's species (1934) clearly shows that *T. zostericola* does not agree with the characters of the genus *Halenchus*. Thus the renaming of this species (Allen, 1955) as *Radopholus zostericola*

(Allgen, 1934) Allen, 1955, is justifiable particularly since Allgen pointed out that the taxa were closely related to *Tylenchus gracilis* de Man, 1880, (=*Radolpholus gracilis* (de Man, 1880) Hirschmann, 1955).

The description of *Halenchus mexicanus* was based on one juvenile female obtained from Aransas Bay, Texas. Chitwood figured the metacorpus to be well defined in shape and with definite valves, and the esophageal glands to be free in the body overlapping the intestine. He estimated the vulva to be located at a point 48 per cent of the body length (presumably connected to amphidelphic gonads) and described the tail to be conoid and not hooked at the tip. In contrast, de Man's description of *H. fucicola* states that the female reproductive system is monodelphic and prodelphic, while Cobb's generic diagnosis for *Halenchus* designates the tail to be ventrally hooked, presumably based on de Man's assertion that this is a good character of *H. fucicola* (Fig. 1, E). This reviewer accepts Cobb's view that the hooked-tail character represents a generic rather than a specific trait. Accordingly *Halenchus mexicanus* is designated as *species inquirenda* pending a future discovery of additional specimens.

The diagnosis for the genus *Halenchus* is emended as follows:

Genus *Halenchus* Cobb, 1933

Diagnosis emended—Tylenchinae. Lip region striated, stomatostyle distinct and knobbed. Metacorpus indistinct, presence of valves questionable. Esophageal glands lying free in body, overlapping intestine. Female gonad monodelphic and prodelphic with vulva situated in latter third of body. Male tail with gubernaculum and caudal alae. Posterior portion of tails of both sexes characteristically hooked. Marine habitat.

Type Species: *H. fucicola* (de Man and Barton in de Man, 1892) Cobb, 1933.

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ADDITIONAL RECORDS OF MARINE FISHES FROM THE VICINITY OF CEDAR KEY, FLORIDA

David K. Caldwell
University of Florida

Since the reports by Reid (1954), Kilby (1955), and Caldwell (1954, 1955), the following fishes have been recorded from the vicinity of Cedar Key, Levy County, Florida.

With the continuing growth of the University of Florida's Seahorse Key Marine Laboratory there, it is hoped that this increasing list of fishes can be added to in published form from time to time, not only for the benefit of workers at the laboratory, but primarily as a definite point of reference in the northeastern Gulf of Mexico which will aid those engaged in zoogeographic studies of Western North Atlantic marine shore fishes.

As in the above papers, the Cedar Key area is arbitrarily restricted to a zone (regularly visited by fishermen from the town) encompassed by a fifteen nautical mile radius from the town of Cedar Key.

Many of the fishes listed below were obtained from a shrimp trawler working approximately six nautical miles WSW of the town, just outside the islands of the area, in 2½ fathoms west of North Key. The fishes so trawled are apparently the first made available to ichthyologists, in recent years at least, from a zone just beyond that usually collected by means other than those employed by sport fishermen using hook and line. The bottom there is hard, consisting primarily of sand, with sparse patches of attached vegetation (mostly turtle grass, *Thallasia,* manatee grass, *Cymodocea,* and various forms of brown algae). Loggerhead sponges are also reported to be numerous there. Specimens referred to below as having been collected by a commercial shrimp trawler come from this zone off North Key. I am particularly indebted to Mr. Doyle Folks, of the Marine Laboratory staff, for arranging for the collection of these fishes (and others listed as well), and to Mr. Charles F. Smith, who actually preserved the specimens on board the trawler.

Specimens designated with a "UF" number are in the University of Florida Collections. The remainder are housed uncataloged in a synoptic collection being maintained at the laboratory on Seahorse Key. Unless otherwise noted, measurements are standard length.

Annotated List

Mystriophis intertinctus (Richardson). Snake eel. A specimen 583 mm. in total length was collected from the commercial shrimp trawler on March 18, 1957.

Bascanichthys scuticaris (Goode and Bean). Snake eel. A 545 mm. specimen (UF 2360) was collected on a shallow flat just off the south side of Seahorse Key by Dr. E. Ruffin Jones and others, of the University of Florida, on May 11, 1956.

Although Cedar Key is listed as the type locality for this species (Goode and Bean, 1880: 343 — as *Sphagebranchus scuticaris*), Reid (*op. cit.*) did not list it, and this is apparently the first specimen reported from Cedar Key since the original description of the species in 1880.

Apogon pigmentarius (Poey). Cardinal fish. I collected a single specimen (UF 1223) of this species, 17 mm. long, on May 9, 1953. It was taken on the grassy edge of the main ship channel near Seahorse Key.

Vomer setapinnis (Mitchill). Moonfish. One 107 mm. specimen of this form was taken from the commercial shrimp trawler on March 23, 1956.

Opisthognathus macrognathus Poey. Jawfish. One specimen (UF 1516), 80 mm. long, was collected by Dr. E. Lowe Pierce, of the University of Florida, from the stomach of a grouper which he took some ten miles southwest of the town of Cedar Key. The identification of this specimen was verified by Dr. James Böhlke, of the Academy of Natural Sciences of Philadelphia, who has recently made special studies of Western North Atlantic jawfishes.

A second specimen, 115 mm. long, also verified by Dr. Böhlke, was taken by the commercial shrimp trawler on March 23, 1957.

Poronotus triacanthus (Peck). Butterfish. The commercial shrimp trawler collected a single 76 mm. specimen on March 23, 1957.

Gobiesox strumosus Cope. A single 55 mm. example, identified as this species by Dr. John C. Briggs of the University of Florida, was taken from a crab-trap set on Old Clam Bank, near Derrick Key (approximately 4½ nautical miles northwest of the town of Cedar Key) on March 18, 1957, by Mr. Artie Hodge.

Gymnachirus williamsoni (Gunter). Naked sole. One specimen, 75 mm. long, was collected by the commercial shrimp trawler on March 23, 1957.

Antennarius ocellatus (Bloch and Schneider). Spotted frog fish. Mr. Hodge collected a 120 mm. specimen of this species on the edge of Seahorse Reef (a shallow sand bar) on November 1, 1956. It was taken approximately eight nautical miles southwest of the town, midway between the iron beacon on the offshore end of the reef and the flashing beacon Number One marking the entrance to the main ship channel into Cedar Key.

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OBSERVATIONS ON ABNORMAL GROWTH OF THE ARMS AND TENTACLES IN THE SQUID GENUS *ROSSIA*[1]

Gilbert L. Voss
University of Miami

Introduction

During the course of a routine examination of the cephalopods collected by the Woods Hole Oceanographic Institution's research vessel ATLANTIS during the Harvard-University of Havana expeditions of 1938-1939 around the coast of Cuba, several cases of abnormal growth were found in the genus *Rossia*. While records of abnormal growth, loss of arms or parts of arms, and regeneration of lost parts are numerous among the octopods and have been well reviewed by Lange (1920), few cases of regeneration have been recorded among the decapodous cephalopods and only one case of abnormal growth is reported in the literature. Okada (1938) reported a case of a branched right ventral arm in *Sepia esculenta* Hoyle.

The small sepiolid squids belonging to the genus *Rossia* are benthic in habitat, living in or on the mud in relatively deep water. Among the specimens taken in the ATLANTIS hauls were large numbers of the small sepiolid, *Rossia* (*Semirossia*) *tenera* Verrill. In making the identifications, which in the genus *Rossia* are often based upon the sucker arrangement on the tentacular clubs, it was first observed that the number of rows of suckers varied widely. While the usual number of rows of suckers is 6 - 7, often only 4 rows were found, consisting always of the larger dorsal suckers. One specimen was examined in which the tentacle on the right side projected from a hole below the bases of the right latero-ventral and ventral arms just anterior to the right eye, and a second specimen was found in which the left tentacle and the left ventral arm had become fused in an unusual manner. This latter case seemed so bizarre that it is considered worthy of full description.

Description

The specimen observed was a female of 13.0 mm mantle length from 150-180 fathoms off Punta Alegre, Camaguey Province, Cuba.

[1] Contribution No. 182 from The Marine Laboratory, University of Miami.

On first examination the left tentacle appeared to be lacking, a not unusual occurrence in this group of squids, but further examination revealed that this tentacle was fused with the left ventral arm. For detailed study the first three pairs of arms were amputated at their bases. Figure 1 shows the abnormal left ventral arm and tentacle and the normal condition of the right tentacle and arm.

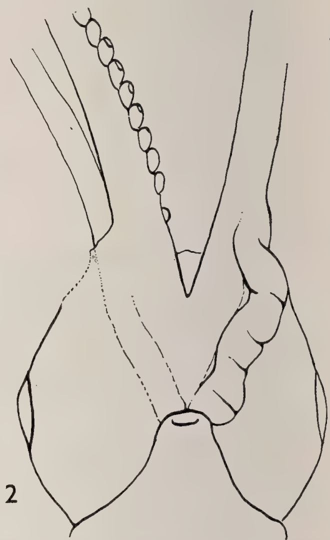

Figure 1. Dorsal view of the fused left tentacle and left ventral arm and the corresponding normal members of the right side.

Figure 2. Ventral view of the ventral arms and tentacles showing the folding of the basal section of the left tentacular stalk and the point of fusion with the left ventral arm.

In a normally developed specimen the right and left ventral arms are mirror images of each other; deeply cleft at the mid-ventral line, stout at the base and tapering to an attenuated point distally. The ventral or inner edge of the arm is smooth and rounded, but the outer or dorsal edge has a broad membrane which extends nearly to the distal extremity of the arm. This membrane is united with the latero-ventral arm about ⅓ of the distance from the base, forming a pocket within which lies the stalk of the tentacle. The inner or oral surface of the ventral arm bears about 18-20 pairs of subglobular suckers which are carried upon delicate peduncles.

The tentacles are long slender appendages, somewhat rounded in cross-section but flattened on their oral surfaces. They are retrac-

tile into deep pockets on the ventral side of the head between and slightly anterior to the eyes. The tentacles may be withdrawn into the pockets until only the sucker bearing and expanded tentacular club is exposed, cradled between the ventral and latero-ventral arms.

In the present specimen the left ventral arm has a length of 16.0 mm in comparison to the right ventral arm which is only 11.0 mm in length, measured from the proximal sucker to the tip of the arm. Proximally, the first 8.5 mm of the arm bears about 8 suckers of normal size and appearance, arranged in what appears to be a single row but which may be two rows. This section of the arm bears no bordering membrane. The distal 7.5 mm of the arm is a normal tentacular club, originating distal to the eighth sucker and consisting of an oval expanded section which is pointed distally and bears about 8 rows of suckers of which the suckers of the two dorsal rows are 2 to 3 times the diameter of the others. The distal 7.5 mm of the arm, corresponding to the tentacular club is bordered by a broad swimming membrane similar to that bordering the right tentacular club.

The abnormal arm was carefully dissected, and Figure 2 shows the actual condition of the arm, consisting of two separate entities just below the point of fusion. The right tentacular stalk may be seen beneath the transparent epidermis, projecting from its pocket between the two ventral arms. In contrast to this the left tentacular stalk is visibly folded upon itself within the pocket and with a sharp folding at the surface. At the base of the left ventral arm the tentacle becomes fused with the arm. Beyond this point, except for a slight differentiation in color and consistency of the muscle layer in the first few millimeters of the arm, no differences can be distinguished beyond the external appearance.

Discussion

From the evidence at hand and the known developmental history of the Rossiinae, the cause of this abnormality may be explained. Apparently, during the embryological development of this specimen, the tentacle failed to grow out of its pocket or the aperture of the pocket failed to open. As a result, the tentacle grew outward beneath the epidermal layer of the ventral arm. During growth the flattened oral surface of the tentacle was appressed to the aboral surface of the arm and the tentacle continued to grow until the

club extended past the end of the arm. Here growth ceased and the tentacle and the arm became completely fused.

It would be interesting to know whether in the case of the branched arm reported by Okada (1938) this could have been formed in a somewhat similar fashion. The abnormalities found in the genus *Rossia* indicate that it may be subject to considerable irregularities of growth, due perhaps to the habitat which it occupies. No cases of abnormal growth or even of regeneration of parts are known to the author in the open ocean oegopsid squids.

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DISTRIBUTION OF Ca^{45} IN THE TISSUES OF A STEER FED GRASS FROM LAND THAT RECEIVED LABELED FERTILIZER [1,2]

R. L. Shirley, W. K. Robertson, J. T. McCall,
J. R. Neller and G. K. Davis
University of Florida

Information is needed concerning the availability for animals of minerals from fertilizers. Shirley, Davis and Neller (1951) traced P^{32} when added as fertilizer to the soil, through the plant and the bovine consuming the plant. Further knowledge with other elements should be helpful in understanding how plants remove elements from the soil and make them available to animals.

In the present study Ca^{45} as labeled $CaCO_3$ was added to the soil on which cattail millet was grown to early maturity. This millet was harvested and fed to a steer. The excretion of the isotope in the feces and urine was followed for 6 days after feeding the labeled grass. At this time the animal was sacrificed and the concentration of the isotope in various tissues was determined. Comparative data were obtained on a steer that was drenched with an aqueous solution of Ca^{45} salt.

Experimental

Five millicuries of Ca^{45} as labeled $CaCO_3$ was mixed in soil at the rate of 1000 pounds per acre. The labeled $CaCO_3$ was prepared by adding additional calcium carrier in the form of calcium acetate to the $Ca^{45}Cl_2$ received from Oak Ridge; the total calcium was precipitated as labeled $CaCO_3$ by adding sodium carbonate. The soil was then seeded with cattail millet. The millet was harvested after 29 days, and cured for one day before feeding. A representative sample of the grass was wet digested with concentrated nitric acid, and aliquots analyzed for Ca^{45} concentration, using calcium oxalate precipitates, thin-window Geiger tubes, and commercial scalers. The grass was found to contain aproximately 3.0 μc (microcuries) of Ca^{45} per kilogram.

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[1] The Ca^{45} was obtained from the Oak Ridge National Laboratory, Oak Ridge, Tennessee, by permission of the Atomic Energy Commission.

[2] Florida Agricultural Experiment Station Journal Series, No. 403.

Two purebred Jersey steers that had been carefully matched in regard to age (9 months), weight (340 ± 10 lbs.), and rate of growth were placed in metabolism racks. One steer was allowed to eat a kilogram of the radioactive millet followed by hay ad libitum plus 3 pounds of grain per day. The other steer was given orally as a drench an aqueous solution containing 210 μc of Ca^{45} as $CaCl_2$ with 5 grams of calcium acetate, and mixed hay and grain as above.

Fecal and urinary collections were made every 24 hours for 6 days after the isotopes were consumed; then the steers were sacrificed and various tissues were analyzed for Ca^{45}. The samples were wet digested and evaluated for activity as described above for the grass.

Results and Discussion

In Table I the data are presented that were obtained for the concentrations of the Ca^{45} found in various tissues of the steers at the time of sacrifice. The Ca^{45} found in the liver, spleen, kidney, heart, gastrocnemius muscle, blood serum, rib, tibia and vertebra indicates that calcium is about equally available from the grass as from the drench. The greater concentration of Ca^{45} observed in the rumen muscularis in case of the steer consuming the labeled grass, compared to the one receiving the inorganic salt drench was probably due to the grass requiring more time to pass through the rumen.

TABLE I

Percentages of Ca^{45} in Various Tissues of Steers 144 Hours After Being Fed Labeled Hay Compared to an Inorganic Salt Drench

Tissue	% Ca^{45} Dose/Kg. Tissue Grass	Drench
Liver	0.003	0.005
Kidney	trace	trace
Heart	0.005	0.002
Gastrocnemius muscle	0.003	0.005
Rumen muscularis	0.38	0.03
Blood serum	0.003	0.012
Rib shaft	2.5	3.3
Tibia shaft	2.1	2.4
Vertebra (dorsal)	1.6	2.1
TOTAL	6.59	7.85

In Table 2 data are shown that were obtained for the rate of excretion of the Ca^{45} in the feces and urine of the steers. The steer that received the drench excreted approximately eight times as much of the Ca^{45} during the first day, and almost two times as much the second day in the feces as the steer that consumed the grass. During the next four days the excretion of the isotope from the two steers paralleled each other quite closely. A total of approximately 62 per cent of the Ca^{45} consumed in the drench was excreted in the feces, compared to 41 per cent of that consumed in the grass during the six-day observation period after dosage of the isotope. Hansard, Comar and Davis (1954) orally dosed a 6 month old bovine with Ca^{45} and observed that approximately 61 per cent was excreted in the feces by 144 hours after dosage. This checks very closely with the 62 per cent obtained in this study for a nine month old steer.

TABLE II

Excretion	Hours After Dosage	Per cent Ca^{45} Excreted Grass	Drench
Feces	24	1.9	15.2
	48	14.1	25.0
	72	13.3	11.2
	96	5.4	6.7
	120	4.3	4.0
	144	2.3	0.1
TOTAL		41.3	62.2
Urine	24	none	none
	48	0.06	0.02
	72	0.04	0.02
	96	0.13	0.02
	120	0.08	0.02
	144	0.01	——
TOTAL		0.32	0.08

The differences in the urinary excretions of the isotope in the steers were not significant. Hansard, Comar and Davis (1954) stated that always less than 0.5 per cent of inorganic Ca^{45}, orally administered to cattle, was found in the urine during a corresponding period.

Summary and Conclusions

Radioactive grass, grown on soil to which Ca^{45} had been added as calcium carbonate was fed to a steer. Urinary and fecal excretion rates of the Ca^{45} was determined over a six-day period after dosage, after which time the steer was sacrificed, and the concentration of the isotope in various tissues was determined. Comparative data were obtained with a corresponding steer that was drenched with a Ca^{45} salt solution.

The source of the Ca^{45} had no significant effect on the deposition of the isotope in the liver, kidney, heart, gastrocnemius muscle, blood serum, rib, tibia and vertebra. Neither did the dietary source affect the percentage excretion of the isotope in the urine. The steer that consumed the labeled grass excreted approximately 41 per cent of the isotope in the feces, compared to 62 per cent excreted by the steer that received the isotope in the drench.

These data demonstrate that calcium applied to the soil, as in this study, is available to grass and to the animal consuming the grass as feed.

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HAWTHORNE EXPOSURES SOUTHEAST OF GAINESVILLE, FLORIDA [1]

E. C. Pirkle
University of Florida

The construction of a new highway (southeast of Gainesville between State Roads 329 and 24) during the spring and early summer of 1955 furnished an unusual opportunity to examine fresh exposures of the lower Hawthorne formation. These exposures show some of the features of Hawthorne sediments. Their post-Hawthorne history illustrates how the work of geological processes and agents have in places superimposed additional irregularities on initially heterogeneous Hawthorne sediments. There is little wonder that borings made for foundation, highway and other studies in such areas penetrate one type of sediment in one locality and at the same depth in a nearby hole an entirely different kind of material.

Because weathering rapidly modifies the appearance of such exposures, photographs were made of the materials as soon as entrance to the cuts was possible. Since the pictures were made, weathering and subsequent highway work has so obliterated the exposures that many of the features shown in the pictures are no longer visible.

The Hawthorne formation (Middle Miocene) is characteristically quite heterogeneous. It is composed largely of various combinations of quartz sand, clay, carbonate (both calcic and dolomitic), and phosphate pebbles and grains. These materials often change laterally and vertically in short distances. In places, lenses of nearly pure clay or sand occur.

About 1.2 miles northeast of the intersection of State Roads 329 and 25 where the new road traverses Colclough Hill, a contact between the irregular erosion surface of the Ocala limestone and the Hawthorne formation could be seen on the west side of the highway (Figure 1). The Hawthorne consists of an impure, dark brown clay which contains lenses of silicified *Ostrea normalis* Dall,

[1] This material was included in the introductory part of a dissertation prepared under the direction of the late Dr. John L. Rich and entitled "Pebble Phosphate of Alachua County, Florida." The dissertation was submitted to the graduate school of the University of Cincinnati in partial fulfillment of the requirements for the degree of Doctor of Philosophy. Some of the field expenses were paid by the Florida Geological Survey.

Figure 1. Exposure in road cut southeast of Gainesville showing contact between the weathered Hawthorne formation (dark) and the solution pitted Ocala limestone (light).

Figure 2. Part of a clay remnant (dark with slight gullying) exposed in road cut along the west side of the highway.

a characteristic Hawthorne fossil. The clay, which when unweathered is a light greenish to greenish gray color, contains a few shark teeth and manatee ribs.

Approximately .2 mile farther northeast and extending for a distance of 500 feet, undisturbed exposures of hardened, Hawthorne clayey sand, two filled sinks in this lithified, clayey sand, and three clay "lenses" were clearly apparent. Figure 2 shows the northeast end of a clay mass, on the west side of the highway, which is completely surrounded by soft, clayey sands and hardened, phosphatic, clayey sands. The clay "lens" is light green to greenish gray and weathers to a yellow or brown color. The clay is non-calcareous and contains only minor quartz sand although occasional sandy partings which consist of quartz sand mixed with grains of soft, white phosphate are present.

The clayey sand below the clay mass is plastic and contains abundant grains of soft, white phosphate and some white to gray pebbles of phosphate. There are also a few balls of phosphatic clay.

Lithified, phosphatic clayey sand occurs above the clay "lens." It is believed that this hardened, clayey sand or loosely cemented "sandstone" is nothing more than a soft clayey sand similar to that below the lens but which has hardened on exposure and weathering. In this "sandstone" a large part of the cementing material is a phosphatic clay.

Considerable evidence of slumpage, including slickensides in clay, distorted bedding and brecciation is noticeable in the "sandstone" just northeast of the clay lens. Joints have developed in the "sandstone" due to slumpage. About 75 feet northeast of the clay "lens" a filled sink in this "sandstone" can be seen clearly. The contact between the fill material and the "sandstone" is abrupt. (Figure 3.) Much of the fill material may be weathered Hawthorne sediments and consists of a mixture of loose brown sand and clay with a few whitish to gray phosphate pebbles and occasional porous "sandstone" pebbles. The "sandstone" beneath the filled sink is highly brecciated.

Approximately 60 feet farther northeast another filled sink occurs in the "sandstone" on the opposite (east) side of the highway. This fill is shown in Figure 4. Here a faint bedding in the "sandstone" can be detected, and the dip distinctly increases toward the sink. The depression presumably was caused by sagging into a sink developed in the underlying Ocala limestone.

Figure 3. View perpendicular to a sloping surface showing sharp contact between Hawthorne "sandstone" (white material under the hammer) and the filling of a sink.

Figure 4. Section in road cut showing dark sediments filling a shallow depression in white Hawthorne "sandstone."

Figure 5 shows the southwest end of the fill shown in figure 4. There, about 2 feet of loose, whitish sand could be seen covering both the Hawthorne "sandstone" and the fill material. This loose sand is thought to be derived from marine Pleistocene terrace sands but might be of the same age as the fill material.

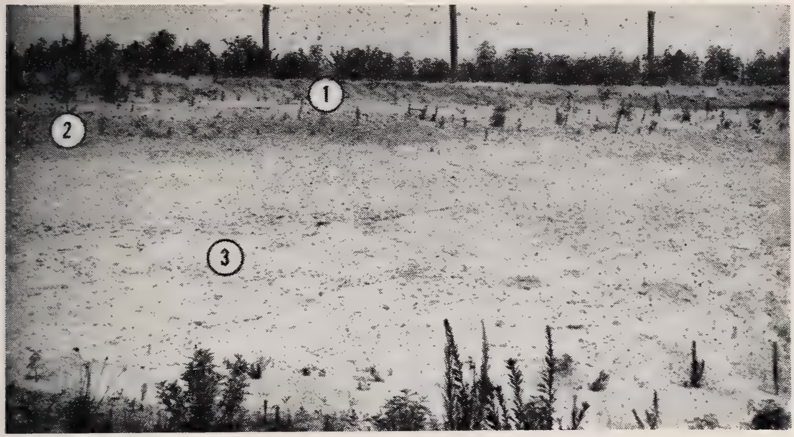

Figure 5. Loose, light colored surficial sands about 2 feet thick (1) covering lens of dark, clayey material (2) above white Hawthorne "sandstone" (3). The fill material in this photograph is the southwest end of the fill shown in figure 4.

The following events are believed to form a part of the history of these exposures.

(a) Marine Hawthorne sediments were laid down upon the highly weathered and solution-pitted surface of the Ocala limestone. The present clay masses such as seen in figure 2 are believed to represent parts of an earlier continuous clay stratum.

(b) Post-Hawthorne uplift of the Ocala arch to the west initiated another sub-aerial erosional cycle. Solution in the underlying Ocala limestone resulted in small collapse sinks, which in the areas of the collapse carried the hardened, phosphatic clayey sand which was above the clay stratum to a lower position. Such collapse resulted in the distortion of the continuous clay stratum such as to give the present appearance of clay "lenses."

(c) This collapse presumably took place after the marine Hawthorne sediments had been uplifted and due to weathering and exposure sufficiently lithified so that they became brecciated while slumping into the sink.

(d) The sinks, which developed in the "sandstone" as a result of solution in the Ocala, were filled by Hawthorne sediments slumped and washed in from the sides.

(e) After the sinks were filled, the sea covered the area and deposited Pleistocene sands which later (according to Harold K. Brooks, personal communication) may have been reworked to form the present thin layer of whitish, surficial sands shown in figure 5.

Acknowledgments

Drs. John L. Rich and William F. Jenks of the University of Cincinnati; Professor Harold K. Brooks, formerly of the University of Cincinnati; and Drs. Walter Auffenberg, Pierce Brodkorb and R. A. Edwards of the University of Florida have critically read the manuscript in which this material was included. They offered many valuable suggestions.

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AUTHORITARIAN ATTITUDES AND ETHNIC PREJUDICE BEFORE AND AFTER TWO COLLEGE COURSES

CARL D. WILLIAMS
University of Miami

Many college teachers accept the view that they have a general responsibility in the field of personal and social development as well as a technical responsibility in their chosen field. However, for most college courses and for higher education in general, objective evidence of such personal and social growth or change is largely unavailable at present.

Do college courses actually contribute to personal and social change in students? If so, what sort of changes occur? And, are changes related to the teaching method or to the subject matter of the course?

A growing body of data is beginning to supply information relative to these important questions. Some of the historical roots of this type of research have been reviewed by Wispé (1953). Birney and McKeachie (1955) have surveyed research in this area involving psychology courses.

The present study is an exploration of the possibility that attitudes related to authority and to minority groups might change between the beginning and end of college social science courses. The present work has stemmed directly from the theoretical formulations and the methodology presented in *The Authoritarian Personality* by Adorno, Frenkel-Brunswik, Levinson, and Sanford (1950). These psychologists have endeavored to show that ethnic prejudice and antidemocratic ideology are expressions of a type of man whose personality structure seems to be characterized by rigidity, conventionality, dependency, repressive denial, destructiveness, and a pervasive orientation toward power and authority. Titus and

Hollander (1957) have reviewed the great amount of research that has been stimulated by the work of Adorno, et al.

The specific purpose of the present investigation is to measure attitudes on two of the scales reported in *The Authoritarian Personality* before and after two social science courses.

Method

Two regular social science classes in the College of Arts and Sciences of the University of Miami were used. One was a course in conservation in the geography department and the other was a course in applied psychology. Both were evening classes offered during a six-weeks summer session. The total enrollment in these two classes combined was approximately fifty. However, not all of the students were present at both the first and the second-last class meetings when the data was gathered.

Two attitude scales were used to provide objective surface measures of authoritarianism and of ethnocentrism (ethnic prejudice). The first was the 30-item authoritarianism scale (F scale), form 45, from *The Authoritarian Personality.* Because it was no longer timely, item 22 of this scale was replaced by item 5 of form 60. The items on the F scale involve attitudes about parent-child relations, morality, and people generally, all matters about which there are no uniform opinions in our culture.

The second attitude scale was the ethnocentrism scale (E scale). The 16 items were taken from form 45 and from the final form of the E scale from *The Authoritarian Personality.* The items were selected so that none of them mentioned Jews. E scale items involve attitudes about patriotism and various minority groups.

High scores on these scales are indicative of autocratic viewpoints and ethnic prejudice. Low scores are indicative of a more liberal, equalitarian approach to life and other people and of less prejudice.

Both courses were conducted in their usual fashion with no emphasis upon prejudice, or authoritarianism.

Results

The mean scores on the two attitude scales for both classes combined are presented in Table 1. The data represent scores of 41 students on the F scale and of 38 students on the E scale. The differences between the pre and post averages are not statistically significant. The correlation between the scores on the initial and

second testing on the F scale was .89. A similar correlation for the E scale was .67. These correlations indicate a strong tendency for scores on the second testing to be similar to scores on the first testing.

TABLE 1

Mean Attitude Scores for Both Classes Combined

	F Scale	E Scale
First testing	3.339	3.211
Second testing	3.344	3.221
Difference	.005	.010

The data were also analyzed for each class separately. There were no significant changes between the pre and post testing in either class on either scale. There were no significant differences between the two classes for the pre or the post testing on either scale. And, the net difference between the two classes from pre to post testing was not significant for the F scale or for the E scale.

Discussion

It is clear that the average amount of ethnic prejudice and of authoritarian attitudes did not change from the beginning to the end of the two social science courses. This finding is consistent with Lagey's report (1956) that there were no changes in attitudes toward the Negro from the beginning to the end of three social science courses (introductory anthropology, introductory sociology, and introductory social disorganization).

However, Levinson and Schermerhorn (1951) have reported changes in authoritarian attitudes and ethnic prejudice over a six weeks course. As in the present study, they used the F scale and the E scale. The course involved was an intergroup relations workshop with an enrollment of 32 students. The difference between the findings of Levinson and Schermerhorn and of the present study may be due in part to different purposes of the courses. The conservation and applied psychology courses were directed toward a consideration of the facts and principles of those subjects. The intergroup relations workshop was directed toward understanding prejudice and studying possible actions for the reduction of intergroup tensions. Thus the entire workshop was oriented around authoritarian attitudes, ethnic prejudice, and related topics.

While no change was found in the present investigation, neither were the students less liberal or more prejudiced at the end of the courses. That it is possible for unpredicted or undesired changes to occur from the beginning to the end of college courses has been reported by Eglash (1957). This researcher found that students in three psychology classes were more opinionated at the end of the courses than at the beginning.

Various lines of psychological evidence suggest that authoritarian attitudes and ethnic prejudice are acquired over many years of interaction in family and social environments. Thus unless concentrated effort is directed toward changing such attitudes, it may be unrealistic to expect changes over the relatively short period of a college course. However, it may be that the cumulative effect of many college courses and the campus atmosphere over the total college period may produce measurable changes in these important attitudes. Research into this possibility is in progress.

Acknowledgments

I wish to thank the students in the two classes and Dr. Robert N. Ford, formerly Assistant Professor of Geography at the University of Miami, for their assistance in this investigation.

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Quart. Journ. Fla. Acad. Sci., 20(3), 1957.

GENERAL BIOTIC RELATIONS OF THE FLORIDA MAMMAL FAUNA[1]

H. B. Sherman
DeLand, Florida

The first version of this paper was presented by the author at the 1951 meetings of the Florida Academy of Sciences. This was part of a symposium on "The Biotic Position of Florida" arranged by Dr. H. Arliss Denyers, Chairman of the Biological Sections of these meetings. The following year (Sherman, 1952), "A list and bibliography of the mamamls of Florida, living and extinct," was published in this journal. In the following pages an attempt is made to describe in general terms and with little technical language the relationships in time and space of the families and genera of mammals which have been recorded from Florida and to bring up to date the list of recent mammals. Literature essential to this paper is cited to supplement the bibliography published in 1952. However, no attempt has been made to make this bibliography complete.

The biotic relations of the terrestrial mammal fauna of Florida is of unusual interest due to the preservation of many fossil forms since Miocene times and to the geological history of this part of the country. Geographic changes since the last ice age of the Pleistocene have isolated many terrestrial populations. Also the Florida peninsula is extensive and its various habitats have provided conditions under which the differentiation of species and geographic races has flourished. The extensive shore line has furnished numerous records of marine forms.

Counting fossils, 148 genera of mammals have been recorded from Florida (Table 1). The most ancient of these, *Basilosaurus*, an extinct, toothed whale, has the distinction of being the only mammal in this list of Eocene age. None are known from the Oligocene, but there are 43 or 44 from the Miocene, 16 or 17 from the Pliocene, 58 from the Pleistocene and a like number are listed as Recent. However, the latter group includes the bison and Florida wolf, both of which are now extinct in Florida, 10 genera of bats, 14

[1] For assistance in the preparation of this manuscript I am indebted to Stanley J. Olsen of the Florida Geological Survey and James N. Layne of the University of Florida for constructive criticism and to my daughter, Mrs. G. E. Phillips, for typing.

genera of whales and the introduced house rat, house mouse and armadillo. The relatively small number of genera recorded from the Pliocene probably indicates that correspondingly favorable collecting localities for this age have not been located, as compared with those for the Miocene and Pleistocene.

The record of the Miocene fauna of Florida is remarkable in that it furnishes most of the records of Miocene mammals in North America east of the 95th meridian. Among these are represented the following six families, four of which became extinct before the Pliocene. The Mylagaulidae and Protoceratidae are the exceptions. The Mylagaulidae were stout bodied rodents, which suggests that they burrowed like pocket gophers. Rhinoceros-like horns were present on the nose of some of these. The Entelodontidae consisted of giant pigs with a shoulder hump. Some stood as much as six feet high and were ten feet long. Like many modern artiodactyls they possessed only two toes on each foot. The Hypertragulidae were a kind of pigmy deer, with tusklike canine teeth. The Protoceratidae were larger and some, presumably males, possessed two pairs of giraffe-like horns. Little is known of the Nothokematidae, but they were probably somewhat similar to the protoceratids. Evidence that oreodonts of the family Merycoidodontidae lived in Florida consists of a single tooth. Members of these families are known from North America only, with the exception of the giant pigs, which also occurred in the Oligocene of Europe and Asia.

Among the marine mammals recorded from the Florida Miocene are members of two families of whales, which became extinct in the Pliocene. These are the Acrodelphidae, the long-beaked porpoises and the Cetotheridae. The latter were primitive whalebone whales. Although it is generally believed that the whale-bone whales were derived from toothed whales, teeth were lacking in these cetotherids.

Goniodelphis hudsoni, the only Florida representative of the river dolphin family, Platanistidae, is of uncertain age, but is either from the Miocene or Pliocene. River dolphins are now confined chiefly to the fresh water rivers and lakes of South America and Asia. Their occurrence in the Miocene of Europe, North and South America indicates how extensive their wanderings have been.

Among the Sirenia, dugongs, which are now found in the Red Sea and Indian Ocean, have an ancient history which extends back to the Eocene of Europe and Africa. They are known from the

Miocene of Florida and apparently became extinct in North America and Europe before Pleistocene times. Their relatives, the manatees, which comprise the family Trichechidae, did not appear until the Pleistocene. They now live in the warmer parts of the Atlantic Ocean along the coasts of the Americas and Africa. They are also occasionally found in fresh water, such as the St. Johns and Suwannee Rivers.

The following six families of mammals, which are represented in the Florida Miocene, no longer live in this region. The Heteromyidae, which includes the present day pocket rats and mice, spiny mice and kangaroo rats and mice, has no modern representatives in eastern North America, but is abundantly represented in suitable regions in the western part of the continent. Although they have lived in North America since the Oligocene, they have only recently extended their range into South America. Horses of the family Equidae and members of the Rhinocerotidae, Tapiridae and Camelidae occurred in North America from the Eocene to the Pleistocene, with the exception of the rhinoceroses, which disappeared in the Pliocene. Horses and rhinoceroses were also represented in the Eocene of the Old World. It is interesting to speculate on what trails they used and what ecological factors existed which exterminated New World forms and allowed others to survive in parts of Europe, Asia and Africa. Tapirs had reached Asia by the Miocene, but like many other groups, did not reach South America until the Pleistocene. Members of the Camelidae, which reached South America in the Pleistocene, have persisted in the form of the various kinds of llamas, alpacas, vicunas and guanacos. During the Pleistocene other members of the Camelidae apparently reached Europe, Asia and Africa. Of these only the camel and dromedary of Asia have survived. Peccaries of the family Tayassuidae lived in Florida from Miocene to Pleistocene times, but now occur in Texas, Central and South America.

The other five families of mammals represented in the Florida Miocene are still thriving. The histories of the dog family, Canidae, and of the weasel family, Mustelidae, extend back to the Eocene and Oligocene of North America, Europe and Asia. In the Pliocene or Pleistocene members of these groups reached South America and Africa. The deer of the family Cervidae had primitive predecessors in the Oligocene of Europe and Asia. By the Miocene they were in North America and reached South America in the Pleisto-

TABLE 1

Distribution in time and space of the families and genera of mammals recorded from Florida. Florida records are *in italics*. Distribution is chiefly after Simpson, 1945. A= Asia; C= Central America; E= Europe; F= Africa; G= Galapagos; I= West Indies; M= Madagascar; N= North America; S= South America; T= Australia; W= World wide.

Family or genus	Eocene	Oligocene	Miocene	Pliocene	Pleistocene	Recent
Order Marsupialia.						
Didelphidae.—Opossums	S NE	S NE	S NE	S	SCN	SCN
Didelphis. Common opossum				S	SC*N*	SC*N*
Order Insectivora.						
Soricidae.—Shrews		NE	NE	NEA	NEA	NEAF
Sorex. Long-tailed shrews		?	E	NE	NE	*N*EA
Blarina. Short-tailed shrews				N	*N*	*N*
Cryptotis. Short-tailed shrews					*N*	SC*N*
Talpidae.—Moles	E	NE	NE	NE	NE	NEA
Scalopus. Eastern American moles				N	*N*	*N*
Order Chiroptera.						
Phyllostomidae.—American leaf-nosed bats						SCN I
Artibeus. American fruit bat						SC*N* I
Vespertilionidae.—Boreal bats, etc.		E	NE	NE	SCNEA	SCNEA W
Myotis. Little brown bats or myotis		E	E	E	NE	SC*N*EA W
Pipistrellus. Pipistrelles					N	C*N*EA
Eptesicus. Big brown bats					N A	SC*N* W
Nycticeius. Rafinesque bat						*N* I
Lasiurus. Red bat, Seminole bat, hoary bat, etc.						SC*N* I
Dasypterus. Yellow bat						SC*N* I
Corynorhinus. Big eared bat						*N*
Suaptenes			*N*			
Miomyotis			*N*			
Molossidae.—Free-tailed bats		E	E	E	NE	SCNEA W
Molossides					*N*	
Tadarida. Free-tailed bats		E	E	E	E	SC*N*EA W
Eumops. Mastiff bats						SC*N* I

TABLE 1—Continued

Family or genus	Eocene	Oligocene	Miocene	Pliocene	Pleistocene	Recent
Order Primates.						
Hominidae.—Men					W	W
Homo. Men					N W	N W
Order Edentata.						
Megalonchyidae	?	S	S	SCN	SCN I	
Megalonyx. Ground sloth					N	
Megatheridae			S	SCN	SCN	
Megatherium. Ground sloth				SCN	SCN	
Mylodontidae		?	S	S	SCN	
Paramylodon. Ground sloth					N	
Thinobadistes. Ground sloth					N	
Glyptodontidae	S	S	S	SCN	SCN	
Boreostracon. A glyptodont					N	
Dasypodidae.—Armadillos	S	S	S	S	SCN	SCN
Holmesina. Giant armadillo					N	
Dasypus. Texas armadillo, etc.					SCN	SCN
Order Lagomorpha.						
Leporidae.—Rabbits, etc.	N	NEA	NEA	NEA	SCNEAF	SCNEAF
Sylvilagus. Cottontails, marsh rabbits, etc.				?	SCN	SCN
Order Rodentia						
Mylagaulidae			N	N		
Mesogaulus			N			
Sciuridae.—Squirrels, marmots, chipmunks, etc.			NE	NE	NEA	SCNEAF
Sciurus. Tree squirrels					NE	SCNE
Glaucomys. American flying squirrels					N	N
Geomyidae.—Pocket gophers		N	N	N	N	N
Plesiothomomys. A western pocket gopher in the east					N	
Geomys. Eastern pocket gophers				N	N	N
Heteromyidae.—Kangaroo and pocket rats		N	N	N	N	SCN
Proheteromys			N			

TABLE 1—Continued

Family or genus	Eocene	Oligo-cene	Miocene	Plio-cene	Pleis-tocene	Recent
Castoridae.—Beavers		NE	NEA	NEA	NEA	NEA
Castor. Beavers				NEA	NEA	NEA
Castoroides. Giant beavers					N	
Cricetidae.—New World rats and mice		NEA	NEA	S NEA	SCNEA	SCNEAFM
Oryzomys. Rice rats					SCN G	SCN G
Reithrodontomys. Harvest mice					N	SCN
Peromyscus. White-footed mice, deer mice, etc.				N	N	N
Sigmodon. Cotton rats				N	N	SCN
Neotoma. Wood rats				N	N	N
Synaptomys. Bog lemming mice				N	N	N
Pitymys. Pine mice					NEA	NEA
Ondatra. Flat-tailed muskrat				N	N	N
Neofiber. Round-tailed muskrat, water rat					N	N
Muridae.—Old World rats and mice				EA	EA T	EA TW
Rattus. House rats, roof rats, black rats, etc.				?	A	N W
Mus. House mice, etc.				?	EA	N W
Erethizontidae.—Tree porcupines		S	S	S N	SCN	SCN
Erethizon. North American tree porcupines				N	N	N
Hydrochoeridae.—Capybaras				S	SCN	SC
Neochoerus. Giant capybara					SCN	
Hydrochoerus. Capybaras					SCN	SC
Order Carnivora.						
Canidae.—Wolves, dogs, etc.	NE	NEA	NEA	NEA	SCNEAF	SCNEAFT
Daphaenus		N	N			
Tomarctus			N	N		
Canis. Wolves, dogs, jackals, etc.				N	NEA	N W
Vulpes. Red fox, kit fox, etc.			?		NEA	NEAF
Urocyon. Gray fox					N	SCN
Amphicyon		E	NEA	EA		
Aelurodon			N	N		
Pliogulo				N		
Cynodesmus			N			
Temnocyon		N	N			

TABLE 1—Continued

Family or genus	Eocene	Oligocene	Miocene	Pliocene	Pleistocene	Recent
Ursidae.—Bears			E	NEA	SCNEA	SCNEA
Agriotherium. Bear-dog				NEA	A	
Arctodus. Short-faced bear					N	
Euarctos. Black and cinnamon bears, etc.				E	NEA	NEA
Procyonidae. Raccoons, coatis, pandas, etc.			NE	SCNEA	SCN A	SCN A
Procyon. Raccoons				N	SCN	SCN
Mustelidae.—Weasels, skunks, otters, etc.		NEA	NEA	NEAF	SCNEAF	SCNEAF
Aelurocyon			N			
Oligobunis			N			
Mephitataxus			N			
Leptarctus			N	N		
Mustela. Weasel, mink, etc.			NE	NEA	SCNEA	SCNEAF
Mephitis. Striped skunks					N	N
Spilogale. Spotted skunks				N	N	N
Lutra. Otters				NEA	SCNEA	SCNEAF
Miomustela			N			
Felidae.—Cats, jaguars, etc.	E	NE	NEAF	NEA	SCNEAF	SCNEAF
Felis. Puma, domestic cat, etc.				? EA	SCNEA	SCNEAF
Panthera. Jaguar				EA	SCNEAF	SCN AF
Smilodon. Saber-tooth tiger					SCN	
Lynx. Bobcat, lynx					N	NEAF
Order Proboscidea.						
Gomphotheridae.—Mastodons		F	NEAF	NEA	SCN A	
Serridentinus. Serrate-toothed mastodon			NEA	N A		
Mammutidae.—Mastodons			NE F	NEA	N	
Mammut. Mastodon			NE F	NEA	N	
Elephantidae.—Mammoths, elephants				EA	? ?NEAF	AF
Mammuthus. Mammoth					? ?NEAF	

TABLE 1—Continued

Family or genus	Eocene	Oligo-cene	Miocene	Plio-cene	Pleis-tocene	Recent
Order Perissodactyla.						
Equidae.—Horses, asses, zebras	NE	NE	NEA	NEAF	SCNEAF	EAF
Anchitherium. Three-toed horses			*N*EA			
Archaeohippus. Three-toed horses			*N*			
Parahippus. Three-toed horses			*N*			
Merychippus. Three-toed horses			*N*			
Miohippus. Three-toed horses		N	*N*			
Nannippus. Three-toed horses				*N*		
Neohipparion. Three-toed horses				*N*		
Hipparion. Three-toed horses				*N*EAF		
Equus. One-toed horses, asses, zebras, etc.				NEAF	SC*N*EAF	EAF
Tapiridae.—Tapirs	N	NE	NEA	NEA	SCNEA	SC A
Tapiravus			*N*			
Tapirus. Tapirs			?	EA	SC*N*EA	SC A
Rhinocerotidae.—Rhinoceroses	NEA	NEA	NEAF	NEAF	EAF	AF
Caenopus		N	*N*			
Diceratherium		N	*N*			
Teloceras			N	*N*		
Aphelops			N	*N*		
Order Artiodactyla.						
Entelodontidae.—Giant pigs	N ?	NEA	N			
Daeodon			*N*			
Tayassuidae.—Peccaries		N	N	N	SCN	SCN
Floridachoerus			*N*			
Prosthennops			N	*N*		
Platygonus				N	SC*N*	
Mylohyus					*N*	
Tayassu. Modern peccaries					SC*N*	SCN
Merycoidodontidae.—Oreodonts	N	N	N	N		
Genus undetermined			*N*			

TABLE 1—Continued

Family or genus	Eocene	Oligo-cene	Miocene	Plio-cene	Pleis-tocene	Recent
Camelidae.—Camels, llamas, etc.	N	N	N	N	SCNEAF	S A
Oxydactylus. Giraffe—camel			*N*			
Miolabis. Giraffe—camel			*N*			
Megatylopus. Extinct camel				*N*		
Procamelus			N	*N*		
Tanupolama					*N*	
Camelops					*N*	
Hypertragulidae.—Primitive	N A	N	N			
Floridatragulus pigmy			*N*			
Leptomeryx deer		N	*N*			
Hypermekops			*N*			
Nothokemadidae.—Primitive deer			N			
Nothokemas			*N*			
Protoceratidae		N	N	N		
Synthetoceros			*N*	N		
Syndyoceras			*N*			
Cervidae.—Deer, elk, moose, etc.		EA	NEA	NEA	SCNEA	SCNEA
Machaeromeryx			*N*			
Blastomeryx			*N*	N		
Dromomeryx			*N*			
Blastocerus. Pampas deer					SC*N*	S
Cervus. Elk, sambar, etc.				EA	*N*EA	NEA
Odocoileus. Deer					SC*N*	SC*N*
Bovidae.—Bison, cattle, sheep, goats, etc.			E	EAF	NEAF	NEAF
Bison. Wisent, bison					*N*EA	*N*E
Order Sirenia.						
Dugongidae.—Dugongs	E F	E	NEA	NEA		Red sea, etc.
Hesperosiren			*N*			
Felsinotherium			*N*			
Trichechidae.—Manatees				NE	SCN	SCN F
Trichechus. Manatee					SC*N*	SC*N* F
Order Pinnipedia.						
Phocidae.—Seals			N	N F	N	All seas
Monachus. Monk seal						Pacific *N* I
Cystophora. Hooded seal						*N*

TABLE 1—Continued

Family or genus	Eocene	Oligo-cene	Miocene	Plio-cene	Pleis-tocene	Recent
Order Cetacea.						
Basilosauridae.—Archiac whales	N F	E				
Basilosaurus	*N*					
Platanistidae.—River dolphins			S NE	S N	S N	S A
Goniodelphis			?	?		
Ziphidae.—Beaked whales			S NE	E		All oceans
Mesoplodon. Gervais' whale			NE	E		*N*
Ziphius. Two-toothed whales						All *N* oceans
Physeteridae.—Sperm whales			S NE	NE T	N	All oceans
Physeter. Cachalot			NE		N	All *N* oceans
Hoplocetus			E	*N*		
Kogiopsis				*N*		
Kogia. Pigmy sperm whale [1]						*N*
Acrodelphidae.—Long-beaked porpoises			NE F	N		
Pomatodelphis			*NE*	N		
Schizodelphis			*NE* F	NE		
Delphinidae.—Dolphins, porpoises, killer whales			NE	NE	NE	All seas
Megalodelphis			*N*			
Globicephala. Pilot whales, black fish [2]					*N*	*N*
Steno.—Rough-toothed dolphins [2]				E		*N*
Stenella. spotted, bridled dolphins, etc. [3]						*N*
Delphinus. Common dolphins				E		All *N* seas
Tursiops. Bottle-nosed dolphins [2]				E		*N*
Grampus. Killer whale [2]						*N*
Pseudorca. False killer				EA		*N*
Cetotheridae.—Extinct whale-bone whales		E	S NE	E		
Isocetus			*NE*			
Mesocetus			*NE*			
Balaenopteridae.—Whale bone whales			N	NE	N	All seas
Balaenoptera. Rorqual, finback, pike whales, etc.				*NE*	N	All *N* seas
Megaptera. Hump-backed whales				NE	N	All *N* seas
Balaenidae.—Whale-bone whales				E	S	All oceans
Eubalaena. Right whale [4]				E	S	*N*

[1] Atlantic, Pacific and Indian Oceans.
[2] All seas except polar.
[3] Atlantic and Pacific oceans.
[4] All oceans except Arctic.

cene. Porpoises of the family Delphinidae, which are now found in all oceans, are first recorded from the Miocene of North America and Europe. Bats are not often found as fossils, possibly due to their light weight and small size. However, members of the Vespertilionidae have been found in the Oligocene of Europe and the Miocene of North America. Like terrestrial mammals, they apparently did not reach South America until the Pleistocene. Most of the species of bats which live in the colder regions belong to this family.

In the Pliocene and Pleistocene certain kinds of mastodons and mammoths lived in Florida. Members of the Gomphotheridae, serrate-toothed mastodons, lived in other parts of North America, Europe, Asia and Africa in the Miocene. The earliest record for these animals is from the Oligocene of Africa. However, they are unknown from Africa in the Pliocene, during which age they occurred in Florida. Other members of this group lived in the Pleistocene of North and South America, Europe and Asia, but none survived that age. Other mastodons of the family Mammutidae, whose known history starts with the Miocene of North America, Europe and Africa, are known from the Pliocene and Pleistocene of Florida. The earliest records for the Elephantidae are from the Pliocene of Europe and Asia. Others were in North America and Africa in the Pleistocene, including the mammoths which lived in Florida. The only remnant of the large assortment of these great beasts of past ages are the elephants, now restricted to parts of Asia and Africa.

Carnivores which meet the requirements of the bear family, Ursidae, appeared in the Miocene of North America, Europe and Asia. Representatives of this family have lived in Florida since the Pliocene. Bears reached South America in the Pleistocene.

The records of Pleistocene mammals shows that, with the exceptions of bats and whales, all but one of the genera of mammals now living in Florida were represented. The exception is that for the North American flying squirrels, *Glaucomys.*

Certain genera of mammals apparently lived in Florida only during Pleistocene times. A number of edentates belong in this category. They had a long history in South America and arrived in North America in the Pliocene or Pleistocene. These consist of four genera of ground sloths, representing three families, a glyptodont and a giant armadillo. Giant mammals were not rare in

this age. Some of the ground sloths were as large as elephants. A representation of *Megatherium* figured in Scott's History of the Land Mammals of the Western Hemisphere, shows one resting on its hind feet and strong tail, while it is pulling the limb of a tree within reach of its mouth with the strong claws of its fore feet. These claws were curved and they walked on the knuckles of their fore feet rather than placing the palm of the foot on the ground. The glyptodonts looked more like large tortoises than mammals. The shell was formed of many pieces of bone, which dovetailed together to form a strong armor. The tail was also heavily armored and in some species it terminated in a spiked enlargement suggestive of a warclub. Although the modern capybara, *Hydrochoerus,* of South and Central America, is now the largest of living rodents, an even larger variety, *Neochoerus,* was present in the Pleistocene. Another large rodent, the beaver, also had a giant relative, *Castoroides,* which is known only from the Pleistocene of North America. Although beavers, *Castor,* have undoubtedly lived in this part of the country since Pleistocene times, they were nearly exterminated by trapping. They are again becoming established in the western part of the state. Beavers are northern animals and also live in Europe and Asia. Two genera of carnivores, which are known only from the Pleistocene are *Arctodus,* the short-faced bears and *Smilodon,* the saber-tooth tiger. The upper canine teeth of *Smilodon* are long and knife-like. The mouth could be opened very wide and it is believed that they used these teeth to stab and slash. Possibly mastodons and mammoths were their favorite bill of fare.

Eleven genera of mammals, which are recorded for Florida in the Pleistocene, no longer live here, but are represented in other regions. Those which now occur in colder climates include genera for the elk, *Cervus;* red fox, *Vulpes;* flat-tailed muskrat, *Ondatra;* a bog lemming mouse, *Synaptomys;* a western pocket gopher, *Plesiothomomys;* and the North American porcupine, *Erethizon.* Those which are now native to Mexico, Central and or South America consist of *Hydrochoerus,* the capybara; *Panthera,* the jaguar; *Tapirus,* the tapir; *Blastoceros,* the pampas deer; and *Dasypus,* the armadillo. Within the past thirty years the Texas armadillo has been introduced into the state and is again well established in the warmer regions.

The ten genera of modern bats recorded from Florida belong to

three families. In the Phyllostomidae recorded from Florida a leaf-like projection is present on the nose. *Artibeus,* the only genus of this family recorded from Florida, is probably an occasional visitor from Cuba. The Molossidae are characterized by the fact that about half of the tail is free. Of the two genera of free-tailed bats which live here, *Tadarida* is represented in the warmer countries of all parts of the world. The other genus, *Eumops,* is known from south Florida, Cuba, Jamaica and in scattered localities from Brazil to California. In the Vespertilionidae no leaf-nose is present and the tail is nearly or completely enclosed in the interfemoral membrane. Four of our species of vespertilionid bats belong to the closely allied genera *Lasiurus* and *Dasypterus.* Members of these genera are confined to the Americas and their geographic ranges are suggestive of the summer and winter ranges of many species of birds. It is also interesting to note that *Lasiurus cinereus,* the hoary bat, comes south only during the colder months after having reared their offspring in the northern United States and Canada. Three other genera, *Myotis, Pipistrellus* and *Eptesicus* are widely distributed in many parts of the world, including Australia. The big-eared bat, *Corynorhinus,* is restricted to North America, but closely related forms live in Europe, Asia and north Africa. The evening bats of the genus *Nycticeius* are known from the eastern United States, Cuba and Mexico.

Some genera of mammals, which live in this region, are widely distributed even though they are unable to fly. A few are almost confined to the state. *Mustela,* the weasels and mink, and *Lutra,* the otters, have close relatives in North and South America, Europe, Asia and Africa. The relatives of the bobcat, *Lynx,* have a similar distribution, except they do not occur in South America. The bears, *Euarctos;* raccoons, *Procyon;* and squirrels, *Sciurus* are represented by other species in other parts of the Americas, Asia and Europe. Genera of our mammals which occur only in North America, Europe and Asia are those for the wolf, *Canis;* the beaver, *Castor;* moles, *Scalopus;* and a long-tailed shrew, *Sorex.* Genera which occur only in the Americas include those for the opposum, *Didelphis;* a short-tailed shrew, *Cryptotis;* harvest mouse, *Reithrodontomys;* rice rat, *Oryzomys;* cotton rat, *Sigmodon;* cotton-tails and marsh rabbits, *Sylvilagus;* and deer, *Odocoileus.* Genera restricted to North America are those for a short-tailed shrew, *Blarina;* striped and spotted skunks, *Mephitis* and *Spilogale;* flying squirrel, *Glaucomys;* pocket

gopher, *Geomys;* round-tailed muskrat, *Neofiber;* and deer mouse, *Peromyscus.* The Florida deer mouse, *Peromyscus floridanus* and the spotted skunk, *Spilogale ambarvalis* are found only in peninsular Florida. *Neofiber alleni* is almost in this class, but one of its subspecies has strayed into the Okefenokee Swamp of southern Georgia. There is also a Pleistocene record for this genus from Kansas.

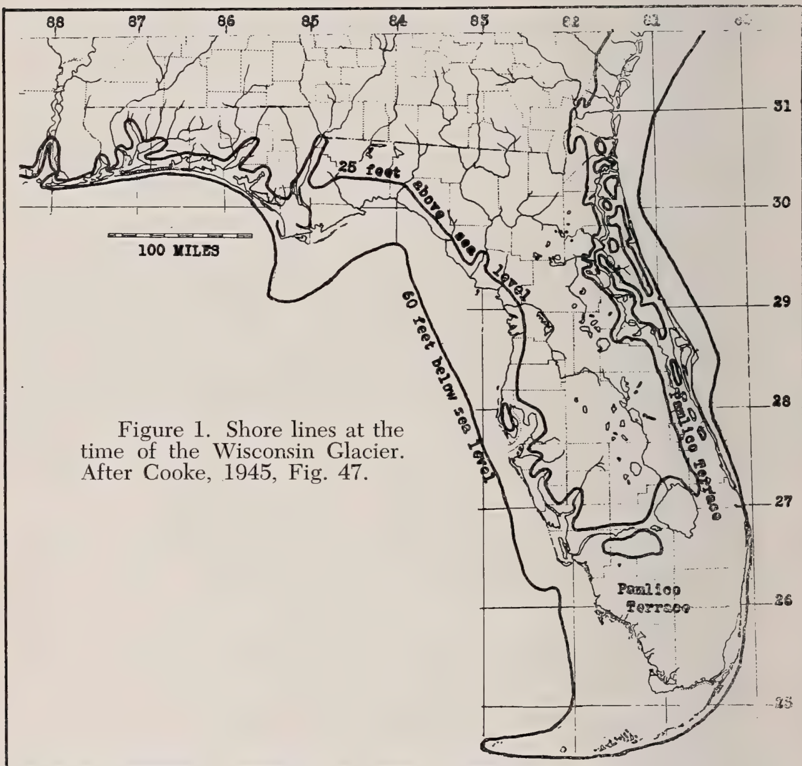

Figure 1. Shore lines at the time of the Wisconsin Glacier. After Cooke, 1945, Fig. 47.

In addition to the species just mentioned, many sub-species or geographic races are confined to the state. The geological history of this part of the world during the Pleistocene undoubtedly played an important part in the differentiation of these populations. During early Pleistocene times, sea level was relatively low, perhaps 300 feet below that of the present age, according to Cooke's Geology of Florida, 1945. This greatly increased the land area of this region. However, the melting of the Nebraskan Glacier swelled

the oceans to such an extent that nearly the entire state was submerged. Some islands remained in the northeastern part and others east of Tampa Bay. One of the latter, near Lake Wales, has an elevation above sea level of more than 320 feet and is the site of Bok Tower. Three other glacial stages, the Kansan, Illinoian and Wisconsin, followed the Nebraskan with other great fluctuations in sea level. However, later fluctuations were not so great as those of early Pleistocene. Apparently at the beginning of the formation of the Wisconsin Glacier, our shore line was about 25 feet higher than at present and now forms the edge of the Pamlico Terrace. This old shore line is now well preserved in many places. Evaporation of water from the oceans to form the Wisconsin Glacier caused the shore line to drop perhaps as much as 60 feet below the recent one, which was formed by the melting of that glacier. An approximation of the positions of these shore lines is given in Figure 1. With the rise in sea level many islands were formed, as a result of which their terrestrial populations were geographically isolated. It is estimated that our present shore line is about 25,000 years old.

Examples of subspecies which probably developed on the Florida keys at the southern tip of the state, with the aid of geographical isolation, are the following:

Procyon lotor inesperatus Nelson, Matecumbe raccoon.
Procyon lotor auspicatus Nelson, Key Vaca raccoon.
Procyon lotor incautus Nelson, Torch Key raccoon.
Sciurus carolinensis matecumbei H. H. Bailey, Key Largo gray squirrel.
Peromyscus gossypinus allapaticola Schwartz, Key Largo cotton mouse.
Sigmodon hispidus exputus G. M. Allen, Pine Key cotton rat.
Neotoma floridana smalli Sherman, Key Largo wood rat.
Odocoileus virginianus clavium Barbour and Allen, Key deer.

The eight races of *Peromyscus polionotus* which occur in the state furnish other examples of differentiation of sub-species. The oldfield mouse, *P. p. subgriseus* occurs in sandy old fields of the northern part of the peninsula. In the region of the Ocala National Forest it intergrades with *P. p. rhodsi*, a race which also lives in old fields almost as far south as Lake Okechobee. Possibly these two races differentiated rather early in Pleistocene times, but not to such an extent as to prevent interbreeding. As sand dunes de-

veloped some of these old field mice became so addicted to them that now they are found on sand dunes almost altogether and their geographical range is usualy less than a mile wide. The color of these beach mice closely matches that of the sand of their habitat. This suggests that selection was brought about by the capture by predators of mice which did not have good protective coloration. One race, *P. p. niveiventris* occurs where dunes are well formed from Miami to New Smyrna Beach. Another race, *P. p. decoloratus* replaces it at Ponce de Leon Inlet. A third race, *P. p. phasma* occurs on Anastasia Island and the adjacent mainland half way to Jacksonville Beach. Similarly in west Florida, *P. p. albifrons* is another old field mouse whose range extends into southern Alabama and Georgia. It also apparently gave rise to races which are confined to sand dunes. *P. p. peninsularis* occurs in the vicinity of Panama City and *P. p. leucocephalus* lives on Santa Rosa Island.

When Howell described *leucocephalus* in 1920, he gave it full specific rank, since it was well marked and isolated from its relatives on the mainland by Santa Rosa Sound. However, by 1932 Sumner had amply demonstrated by means of breeding experiments in the laboratory that *leucocephalus* and *albifrons* readily interbreed and produce fertile offspring. He also indicated how the characters which serve to define these races are inherited. Consequently *leucocephalus* has since been listed as a subspecies.

Possibly the Pleistocene island on the Pinellas Peninsula west of Tampa Bay, is the area where *Peromyscus polionotus rhoadsi* differentiated. A mole, *Scalopus aquaticus parvus* is confined to this region and even a race of big brown bat, *Eptesicus fuscus osceola* occurs in this area, but is unknown in the northern part of the state. Its close relative, *Eptesicus fuscus fuscus* is common in the eastern United States, but rarely is found as far south as the Georgia-Florida boundary.

Another race of bat, Rhoad's myotis, *Myotis austroriparius austroriparius* is the one most often found in the numerous caves which are scattered from Florida Caverns State Park near Marianna southeastward, half the length of the peninsula, through Citrus County. Other subspecies of *Myotis austroriparius* range as far west as Arkansas and as far north as Illinois. Such a geographical distribution is fairly typical of that of many races of mammals which are now native to Florida.

In addition to the isolation produced in Pleistocene times by changes in sea level the peninsula undoubtedly provides partial isolation to terrestrial mammals. Most of the small mammals, which have been studied in this regard, do not travel more than a few miles from the place of birth. Consequently the effects of interbreeding of those which live at opposite ends of the peninsula must be filtered through many generations. As a result an area of intergradation often exists where individuals are found in which characters of both races are intermingled in various ways. This example implies continuous favorable habitats for long distances over long periods of time. The details of what now constitutes a favorable habitat, its extent and its mammal inhabitants have been critically studied in only a few areas in the state. In fact the collector's "blind spots" are still being discovered as evidenced by the fact that in the following list of recent mammals eleven new races are cited which have been described since the 1952 list went to press.

It is obvious from these brief remarks that our present knowledge of the biotic relations of the Florida mammal fauna presents many challenging problems.

Recent Mammals of Florida

Order Marsupialia.—Opossums, pouched mice, kangaroos, phalangers, wombats, etc.

Family Didelphidae.—Opossums.

Didelphis marsupialis pigra Bangs, 1898. Florida opossum.

Order Insectivora.—Shrews, moles, hedgehogs, tenrecs, etc.

Family Soricidae.—Shrews.

Sorex longirostris longirostris Bachman, 1837. Bachman's shrew.

Cryptotis floridana (Merriam), 1895. Florida short-tailed shrew.

Blarina brevicauda carolinensis (Bachman), 1837. Carolina short-tailed shrew.

Blarina brevicauda peninsulae Merriam, 1895. Everglades short-tailed shrew.

Blarina brevicauda shermani Hamilton, 1955. Blind spot shrew.

Family Talpidae.—Moles.

Scalopus aquaticus howelli Jackson, 1914. Howell's mole.

Scalopus aquaticus australis (Chapman), 1893. Florida mole.
Scalopus aquaticus anastasae (Bangs), 1898. Anastasia Island mole.
Scalopus aquaticus parvus (Rhoads), 1894. Little mole.
Scalopus aquaticus bassi A. H. Howell, 1939. Bass's mole
Scalopus aquaticus porteri Schwartz, 1952. Porter's mole.

Order Chiroptera.—Bats.
Family Phyllostomidae.—American fruit bats, leaf-nosed bats, nectar feeders, etc.
Artibeus jamaicensis parvipes Rehn, 1902. American fruit-eating bat.
Family Vespertilionidae.—Includes most boreal species of bats.
Myotis austroriparius austroriparius (Rhoads), 1897. Rhoad's myotis.
Myotis grisescens A. H. Howell, 1909. Gray bat.
Myotis keeni septentrionalis (Trouessart), 1897. Keen bat.
Myotis sodalis Miller and Allen 1928. Indiana myotis.
Pipistrellus subflavus subflavus (F. Cuvier), 1832. Eastern Pipistrel.
Eptesicus fuscus osceolus Rhoads, 1902. Florida big brown bat.
Lasiurus borealis borealis (Muller), 1776. Red bat.
Lasiurus seminolus (Rhoads), 1895. Seminole bat.
Lasiurus cinereus (Beauvois), 1796. Hoary bat.
Dasypterus floridanus Miller, 1902. Yellow bat.
Nycticeius humeralis humeralis (Rafinesque), 1818. Evening bat.
Nycticeius humeralis subtropicalis Schwartz, 1951. Southern evening bat.
Corynorhinus rafinesqui rafinesqui (Lesson), 1818. Long-eared bat.
Family Molossidae.—Free-tailed bats.
Tadarida brasiliensis cynocephala (Le Conte), 1831. Le Conte free-tailed bat.
Eumops glaucinus (Wagner), 1843. Glaucous free-tailed bat.

Order Primates.—Lemurs, aye ayes, pottos, monkeys, marmosets, baboons, apes, men.
Family Hominidae.—Men.
Homo sapiens Linnaeus, 1758. Men.

Order Edentata.—Glyptodonts, sloths, ant bears, armadillos, etc.
  Family Dasypodidae.—Armadillos.
    Dasypus novemcinctus mexicanus Peters, 1864. Texas or nine-banded armadillo.

Order Lagomorpha.—Pikas, hares, rabbits, cottontails, etc.
  Family Leporidae.—Hares, rabbits, cottontails, etc.
    Sylvilagus floridanus floridanus (J. A. Allen), 1890. Florida cottontail.
    Sylvilagus floridanus ammophilus A. H. Howell, 1939. Beach cottontail.
    Sylvilagus floridanus mallurus (Thomas), 1898. Eastern cottontail.
    Sylvilagus floridanus paulsoni Schwartz, 1956. South Florida cottontail.
    Sylvilagus palustris palustris (Bachman), 1837. Carolina marsh rabbit.
    Sylvilagus palustris paludicola (Miller and Bangs), 1894. Florida marsh rabbit.

Order Rodentia.—Squirrels, pocket gophers, beavers, porcupines, rats, mice, etc.
  Family Sciuridae.—Tree, ground, flying squirrels, etc.
    Sciurus carolinensis carolinensis Gmelin, 1788. Southern gray squirrel.
    Sciurus carolinensis extimus Bangs, 1896. Everglades gray squirrel.
    Sciurus carolinensis matecumbei H. H. Bailey, 1937. Key Largo gray squirrel.
    Sciurus niger niger Linnaeus, 1758. Southern fox squirrel.
    Sciurus niger avicennia A. H. Howell, 1919. Mangrove fox squirrel.
    Sciurus niger shermani Moore, 1956. Central Florida fox squirrel.
    Glaucomys volans saturatus A. H. Howell, 1915. Southeastern flying squirrel.
    Glaucomys volans querceti (Bangs), 1896. Florida flying squirrel.
  Family Geomyidae.—Pocket gophers.
    Geomys pinetis mobilensis Merriam, 1895. Alabama pocket gopher.

Geomys pinetis austrinus Bangs, 1898. Southeastern pocket gopher.

Geomys pinetis floridanus (Audubon and Bachman), 1854. St. Augustine pocket gopher.

Geomys pinetis goffi Sherman, 1944. Goff's pocket gopher.

Family Castoridae.—Beavers.

Castor canadensis carolinensis Rhoads, 1898. Carolina beaver.

Family Cricetidae.—New World rats and mice.

Oryzomys palustris palustris (Harlan), 1837. Eastern rice rat.

Oryzomys palustris natator Chapman, 1893. Central Florida rice rat.

Oryzomys palustris coloratus Bangs, 1898. Everglades rice rat.

Oryzomys palustris planirostris Hamilton, 1955. Pine Island rice rat.

Oryzomys palustris sanibeli Hamilton, 1955. Sanibel Island rice rat.

Reithrodontomys humulis humulis (Audubon and Bachman), 1841. Eastern harvest mouse.

Peromyscus polionotus subgriseus (Chapman), 1893. Florida old field mouse.

Peromyscus polionotus rhoadsi (Bangs), 1898. Rhoads' old field mouse.

Peromyscus polionotus niveiventris (Chapman), 1889. Micco beach mouse.

Peromyscus polionotus decoloratus Howell, 1939. Pallid beach mouse.

Peromyscus polionotus phasma (Bangs), 1898. Anastasia beach mouse.

Peromyscus polionotus albifrons Osgood, 1909. White-fronted beach mouse.

Peromyscus polionotus peninsularis Howell, 1939. St. Andrews beach mouse.

Peromyscus polionotus leucocephalus A. H. Howell, 1920. White-headed beach mouse.

Peromyscus gossypinus gossypinus (Le Conte), 1853. Cotton mouse.

Peromyscus gossypinus palmarius Bangs, 1896. Florida cotton mouse.

Peromyscus gossypinus anastasae Bangs, 1898. Anastasia cotton mouse.

Peromyscus gossypinus restrictus A. H. Howell, 1939. Chadwick Beach cotton mouse.

Peromyscus gossypinus telmaphilus Schwartz, 1952. Royal Palm Hammock cotton mouse.

Peromyscus gossypinus allapaticola Schwartz, 1952. Key Largo cotton mouse.

Peromyscus nuttalli aureolus (Audubon and Bachman), 1841. Southern golden mouse.

Peromyscus floridanus (Chapman), 1889. Florida white-footed mouse.

Sigmodon hispidus hispidus Say and Ord, 1825. Northern cotton rat.

Sigmodon hispidus littoralis Chapman, 1889. East Coast cotton rat.

Sigmodon hispidus spadicipygus Bangs, 1898. Cape Sable cotton rat.

Sigmodon hispidus exputus G. M. Allen, 1920. Pine Key cotton rat.

Sigmodon hispidus floridanus A. H. Howell, 1943. Central Florida cotton rat.

Sigmodon hispidus insulicola A. H. Howell, 1943. Captiva Island cotton rat.

Neotoma floridana floridana (Ord), 1818. Florida woodrat.

Neotoma floridana smalli Sherman, 1955. Key Largo woodrat.

Pitymys parvulus A. H. Howell, 1916. Florida pine mouse.

Neofiber alleni alleni True, 1884. Central Florida water rat.

Neofiber alleni apalachacolae Schwartz, 1953. Apalachicola water rat.

Neofiber alleni nigrescens A. H. Howell, 1920. Okechobee water rat.

Neofiber alleni struix Schwartz, 1952. South Florida water rat.

Family Muridae.—Old World rats and mice.

Rattus rattus rattus (Linnaeus), 1758. Black rat.

Rattus rattus alexandrinus (Geoffroy), 1803. Roof rat.

Rattus rattus frugivorus (Rafinesque), 1814. Fruit rat.

Rattus norvegicus (Erxleben), 1777. Norway rat.

Mus musculus domesticus Rutty, 1772. House mouse.

Mus musculus brevirostris Waterhouse 1837. Southern house mouse.

Order Carnivora.—Dogs, bears, raccoons, weasels, hyenas, cats, etc.

Family Canidae.—Dogs, wolves, foxes, etc.

Canis niger niger (Bartram), 1791. Florida wolf.

Urocyon cinereoargenteus floridanus Rhoads, 1895. Florida gray fox.

Family Ursidae.—Bears.

Euarctos americanus floridanus (Merriam), 1896. Florida black bear.

Family Procyonidae.—Raccoons, cacomistles, coatis, kinkajous, pandas, etc.

Procyon lotor elucus Bangs, 1898. Florida raccoon.

Procyon lotor varius Nelson and Goldman, 1930. Alabama raccoon.

Procyon lotor inesperatus Nelson, 1930. Matecumbe raccoon.

Procyon lotor auspicatus Nelson, 1930. Key Vaca raccoon.

Procyon lotor incautus Nelson, 1930. Torch Key raccoon.

Procyon lotor marinus Nelson, 1930. Chokoloskee raccoon.

Family Mustelidae.—Weasels, martens, wolverines, skunks, otters, badgers, etc.

Mustela frenata olivacea Howell, 1913. Alabama weasel.

Mustela frenata peninsulae (Rhoads), 1894. Florida weasel.

Mustela vison lutensis (Bangs), 1898. Florida mink.

Mustela vison evergladensis Hamilton, 1948. Everglades mink.

Mephitis mephitis elongata (Bangs), 1895. Florida striped skunk.

Spilogale putorius (Linnaeus), 1758. Alleghenian spotted skunk.

Spilogale ambarvalis Bangs, 1898. Florida spotted skunk.

Lutra canadensis vaga (Bangs), 1898. Florida otter.

Family Felidae.—Cats, pumas, jaguarundis, lions, tigers, etc.

Felis concolor coryi Bangs, 1899. Florida puma.

Lynx rufus floridanus (Rafinesque), 1817. Florida bobcat.

Order Artiodactyla.—Pigs, peccaries, hippopotamuses, camels, deer, giraffes, cows, etc.

Family Cervidae.—Deer, elk, sambar, moose, reindeer, etc.

Odocoileus virginianus virginianus (Boddaert), 1784. Virginia deer.

Odocoileus virginianus osceolus (Bangs), 1896. Florida white-tailed deer.

Odocoileus virginianus seminolus Goldman and Kellog, 1940. Seminole deer.

Odocoileus virginianus clavium Barbour and Allen, 1922. Key deer.

Order Pinnipedia.—Seals, sea lions, elephant seals, walruses.

Family Phocidae.—Seals.

Monachus tropicalis (Gray) 1850. Monk seal.

Cystophora cristata (Erxleben), 1777. Hooded seal.

Order Cetacea.—Whales, dolphins, porpoises, etc.

Family Ziphidae.—Beaked whales.

Mesoplodon europaeus (Gervais), 1848-52. Gervais' whale.

Ziphius cavirostris G. Cuvier, 1823. Cuvier's beaked whale.

Family Physeteridae.—Sperm whales.

Physeter catodon Linnaeus, 1758. Cachalot or sperm whale.

Kogia breviceps (Blainville), 1838. Pygmy sperm whale.

Family Delphinidae.—Porpoises, dolphins, killer whales, black-fish, etc.

Globicephala macrorhyncha (Gray), 1846. Pilot whale, black fish, etc.

Steno rostrata Gray, 1846. Rough-toothed dolphin.

Stenella plagiodon (Cope), 1866. Spotted dolphin.

Stenella frontalis (G. Cuvier), 1829. Bridled dolphin.

Stenella longirostris (Gray), 1828. Long-beaked dolphin.

Delphinus delphis Linnaeus, 1758. Common dolphin.

Tursiops truncatus (Montague), 1821. Bottle-nosed dolphin.

Grampus orca (Linnaeus), 1758. Killer whale.

Pseudorca crassidens (Owen), 1846. False killer.

Family Balaenopteridae.—Whalebone whales.

Balaenoptera physalis (Linnaeus), 1758. Finback.

Balaenoptera borealis Lesson, 1828. Sei whale, Pollack whale, etc.

Balaenoptera acutorostrata Lacepede, 1804. Pike whale.

Megaptera nodosa (Bonaterre), 1789. Humpbacked whale.

Family Balaenidae.—Whalebone whales.

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THE USE OF CELERY AS A PART OF A RANDOM DIET IN A PROGRAM FOR WEIGHT REDUCTION [1]

Clarence Bernstein, M.D., S. D. Klotz, M.D.,
William G. O'Reagan and Tybell Kahn
Orlando, Florida

Object of Investigation

The actual and potential hazards of obesity have been thoroughly pointed out in studies on cardiovascular diseases and diabetes, and by actuarial statistics gathered by the insurance companies and life extension institutes. Long-standing fashion dictates, television, commercial art, and bathing suit manufacturers have added further impetus to the mass trend toward slenderizing. Basic to this new glorification of the human figure, particularly the female, is a drive which runs afoul of an equally primitive desire to feed or be fed. Present-day fatigue and frustrations being what they are, this latter drive is apt to be even more intense, and the fundamental gratification of the urge to eat is very likely to be achieved.

Realizing this, many and various efforts have been made to reduce the appetite by a) curbing it with drugs, or b) satisfying it in good part with artificial non-calorie foods, or by combining a) and b). These methods have proven of considerable help, but often they leave the dieter jittery and shaky, or weak with hunger. He complains of a "hollow middle", and sleepless nights. The use of low-calorie diets, while sound, is often too restrictive and the patient soon rebels, or "cheats" to a standstill or even a reversal of the downward trend of weight.

The ideal weight reduction program seemed to us to be one that would allow the patient to eat a reasonably free choice of foods, and at the same time enable him to feel that he was "eating enough", and feeling as "full" as he would like to feel, i.e., "satisfied".

With these ideas in mind, we cast about for a suitable filler and ingestible, and very promptly discovered that celery was practically the ideal substance. Abundantly available, a natural rather than synthetic, (and likely less costly) product, here was a material that was chewable, mouthfilling, and swallowable. It had a pleasant

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taste, and supplied effective gastrointestinal bulk, something for peristalsis to work on and be quieted.

The mineral content of celery showed it to be high in sodium and chloride, 0.096% and 0.137%, respectively, and low in calories, 0.22 C per gram. Physically, it was an attractive product, chewy, crunchy, with a high fiber and moisture content. The question of tolerance of this roughage by the irritable or spastic gastrointestinal tract, and the incidence of celery allergy were considered. Likewise, the problem of salt and water for the overloaded or borderline cardiovascular system was evaluated in relationship to the patients, as well as to the immediately previous diets as recorded at the initial interview. If, we felt, we could show that weight could be lost effectively on a celery-and random diet, and just as effectively as with other means, such as anorrhectic drugs, synthetic bulks, and low-calorie diets, then we would be justified in recommending this natural food substance where weight reduction was indicated. Accordingly, we set out first to see if patients could lose weight on celery used adjunctively with random or "free" diets.

Materials and Methods

First Series

Celery and Free Diets:

Seventy eight volunteers started the experimental study, twenty three of whom remained on the diet for at least ten weeks and were analyzed for weight loss. 21 were females; 2 were male. The age range was 24 to 70, the average female age 43; male age 51.5. The range of weights was 140-236.5 for the women; 178-245 for the men. The average duration of obesity was 15.5 years for the females; 13.5 for the males.

Patients were examined by the consulting physicians and certified for the diet trial. Weights and blood pressures along with pertinent observations were recorded at weekly intervals. A dietitian gave all the instructions covering the use of regularly eaten foods and as regards celery specifically as follows:

> Consume one average size stalk (bunch) of celery per day. One-half hour before lunch eat 4 to 6 ribs of celery, and repeat this before dinner. Prepare celery by removing each rib separately; wash it thoroughly; remove any soiled or discolored areas. Place celery ribs in refrigerator in a jar containing a little water. Chill it thoroughly before

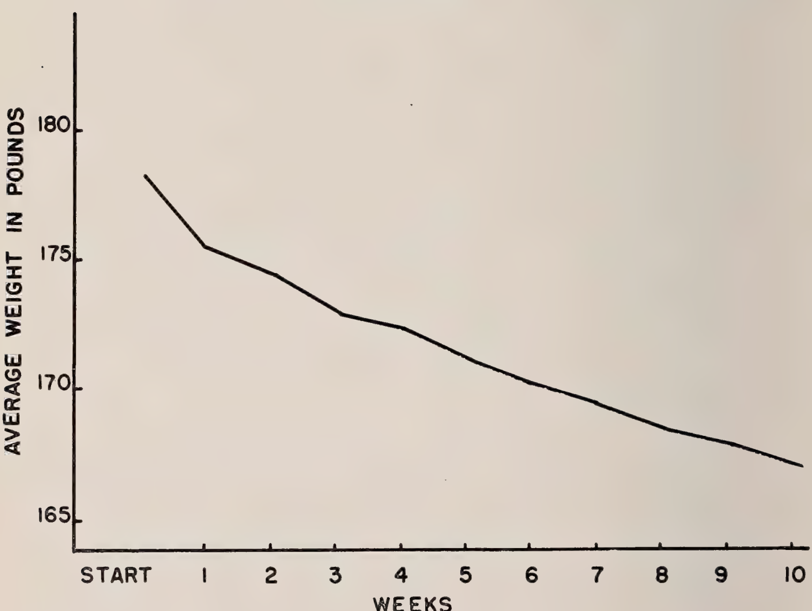
> eating. Crisping improves the flavor and makes further seasoning unnecessary. If you are a 'nibbler', keep the celery handy so you can reach into the refrigerator whenever you wish to eat something. Eat the celery freely between meals.

All celery was supplied to the dieters, who reported each week to the dietitian for weight recording and further instructions or answers to questions as they arose.

Results:

Twenty three participants continued for at least ten weeks. Everyone lost weight. Average percentage loss was 6.5 for females; 3.9 for males. Average loss of weight was 11.3 pounds for females; 8.2 pounds for males (see Table I). Graphs X and Y (A) show the trends in the average weekly weights and average weekly weight losses of the dieters in the first series.

Graph X



FIRST SERIES

Average weekly weights of 23 dieters who remained on celery diet for ten weeks, with missing data for individuals estimated by averaging the weeks adjoining the missing weeks.

TABLE I

WEEKLY WEIGHTS OF 23 DIETERS
WHO REMAINED ON CELERY DIET FOR AT LEAST TEN WEEKS

		Starting Weight	End of 1st Week	End of 2nd Week	End of 3rd Week	End of 4th Week	End of 5th Week	End of 6th Week	End of 7th Week	End of 8th Week	End of 9th Week	End of 10th Week
	1	137¾	135	133	134¼	133½	131¾	—	131	131	129½	—
	2	203	201	203	201	203	200¾	201½	199¼	198¼	199¾	198
(Male)	3	245	237½	232¾	234¾	—	234¾	234	—	234	234½	234½
	4	185	184½	182½	—	180	179	—	179	179¼	—	182¾
	5	169½	167	166½	166	166½	163¼	161½	160¾	161½	160	168½
	6	212	209	211	204¾	207½	210½	205¾	201½	202½	201½	—
	7	142¾	140	139	138½	—	138¾	138¼	—	135½	134	133¼
	8	151¾	150¾	149¼	149¼	—	—	148½	149	145¼	146	143
	9	177½	174	173½	172½	171½	167½	169	167¾	—	166¼	164½
	10	185	181¼	180	178½	—	—	174½	173¼	171¾	170¾	170¾
	11	191½	187	183½	180½	180	177½	177¼	—	—	176	176
	12	149½	149½	149	—	147	146¼	143½	144	141¾	141	140
	13	181½	175½	177	173	172½	167¼	164½	163¼	161½	160	159¼
	14	190¼	188½	188½	186¼	186	—	—	186¼	182¼	180¼	—
	15	200½	201½	201	199¾	—	196	194	193	192	190¾	189
	16	169	168	168½	166½	166	163	163	162	161½	—	159¾
	17	236½	232½	228½	—	226	223¾	222¾	222½	221¾	—	224
(Male)	18	178	176¼	179	175¼	172¾	171	170¾	169½	168	169	172
	19	140	138	140	138	135½	—	132	132½	131¼	132	130
	20	142½	142½	139	139½	—	141½	139½	136½	135	133½	131½
	21	202	193½	191½	190	188	186	184¾	183½	184¾	180	178½
	22	159	153	153¾	153½	150	—	—	—	—	152½	152
	23	163½	162½	160	159½	157	158½	155½	156	—	151½	152

NOTE: A simple statistical test (student's t) indicates that the average weight loss for the ten-week period is significantly different from zero.

Tentative Conclusions:

It was shown that *on a free diet* and using celery as a "filler" this group of obese individuals lost significant weight. Subjectively, the patients reported "feeling better", that celery satisfied the hunger sensation, improved "nerves" and sleep, bettered bowel habits, and "disposition" was good all through the study. There were those rare exceptions who reported constipation, irritable bowel, or failure to diminish appetite, but the number was too small to be significant. The overall impression was that these were happy dieters and thought it "an easy way to lose weight".

There were obvious controls lacking, now that we had shown that weight could be lost on this regimen. No other material to substitute for celery was used. To what extent was the "group factor" operating to induce friendly competition particularly to earn the plaudits of the dietitian? What effect did the personality of the dietitian have in inducing conscious and unconscious self-restriction of foods desired by the dieter? Was the mere fact that the foods eaten were written down as part of the weekly report a cogent deterrent to the extra or "foolish" calorie?

Whether or not these questions could be adequately answered, the positive results obtained warranted the pursuit of a similar study of a second series with some sort of controls for comparison.

Second Series

Objectives:

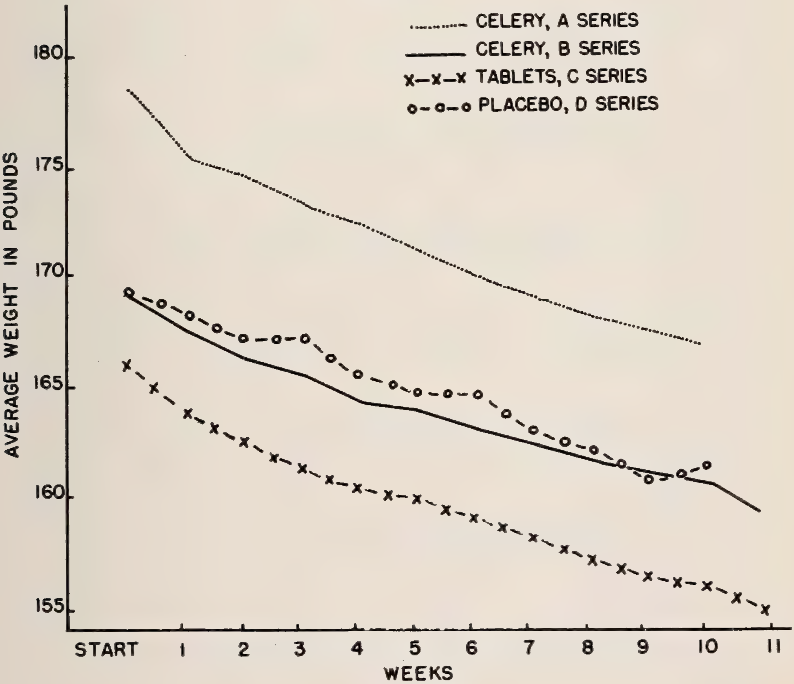
In this group we wished to study as many dieters as we could keep under serial observation grouped as follows:

B. On celery and free diet (Same as First Series)
C. On a tablet and free diet
D. On a placebo and free diet

The tablet for Group C was a methyl cellulose tablet with hydrophyllic properties, causing it to swell up as a soft bulk when dropped into the gastric fluid, thus occupying space, and helping to fill the stomach as foods are eaten. The placebo tablet, made to look like the tablet in C, was furnished by Eli Lilly Company and made of a loosely slubbed calcium lactate which dissolved readily in the stomach without increase in bulk, but did give the patient something to swallow. In each case, the tablet was taken singly before lunch and dinner.

Sixteen, twenty one, and seven subjects, all female, were followed for 12 weeks in groups B, C, and D, respectively. Larger numbers of dieters were more desirable, but only those who continued through the 12 week period were counted as valid for the study. This excluded the few males in this series. The starting groups were matched as nearly as possible as regards weight and age, and duration of obesity. The routine was carried out as in the first series except that tablets were substituted for celery in groups C and D, and B reproduced A of the first series. The reduced number of

Graph Y



SECOND SERIES

Average weekly weights of dieters who remained on diet for at least twelve weeks. Data for individuals missing a particular week estimated by averaging the adjoining weeks. Series A data plotted for comparison with Series B.

NOTE: Statistical tests indicate that the time rate of average relative weight loss was significantly greater for tablets compared to celery and placebo; that the time rate of average relative weight loss for celery and placebo did not differ significantly; and that all three series had a negative time rate of average relative loss that differed significantly from zero.

SECOND SERIES — TABLE II

WEEKLY WEIGHTS OF SIXTEEN PERSONS WHO MISSED
NO TWO CONSECUTIVE WEEKS OF THE CELERY ROUTINE

DIETER	Starting Weight	End of 1st Week	End of 2nd Week	End of 3rd Week	End of 4th Week	End of 5th Week	End of 6th Week	End of 7th Week	End of 8th Week	End of 9th Week	End of 10th Week	End of 11th Week	End of 12th Week
1	176	175	173	171½	172½	170	170¼	—	165½	164¾	165½	162½	161¾
2	180	178	175¾	174½	173	172	170½	172	170	168¾	167½	167½	—
3	203	202¼	201¼	198½	196¼	196¼	195½	196	192½	193½	192½	191¾	189½
4	126	124¼	125¼	125¼	125	125	124¾	125¾	—	125½	126¾	125	124½
5	189	187½	187	187	183	182¾	182	—	183	179	177	175¾	176½
6	178	176	173½	171½	168½	170½	172	165	164½	165½	168½	160½	159½
7	151½	154	149¼	151¼	149¾	150¼	150¾	148½	147½	145	—	145	141½
8	155½	152½	153¾	152¾	152	152	151¼	152¾	152	152¼	151½	151¾	151
9	140	140	138	139	137¾	136¾	137½	137½	135¾	135¼	135¾	135	134¼
10	157½	157	156	153½	152¾	154½	152¼	153¼	152	—	152¼	152½	150½
11	167½	167	165	164	163¼	161½	161½	160¼	160¼	161	159½	157¾	—
12	189½	185¾	185¼	182½	182½	181¼	181	181½	180½	179	180½	176¼	175
13	184½	181¼	180½	180½	—	180½	177½	—	175	177¾	—	175¾	173¾
14	162	158	159	161½	157	156	158	154¼	155¼	153½	151½	150¼	149½
15	183	182½	180¾	178	178¼	177¾	177	177	177	175½	174	175	175
16	175¼	172¾	172	171½	170¾	169¾	168	167	166	166¼	166¾	—	164½
Average	169.91	168.35	167.20	166.42	165.17	164.80	164.36	163.59	162.65	162.16	161.95	160.49	—
Av. Loss	—	1.51	1.15	0.78	1.25	0.37	0.44	0.77	0.94	0.49	0.21	1.46	—

SECOND SERIES — TABLE III

WEEKLY WEIGHTS OF TWENTY-ONE PERSONS WHO MISSED NO TWO CONSECUTIVE WEEKS OF THE TABLET ROUTINE

DIETER	Starting Weight	End of 1st Week	End of 2nd Week	End of 3rd Week	End of 4th Week	End of 5th Week	End of 6th Week	End of 7th Week	End of 8th Week	End of 9th Week	End of 10th Week	End of 11th Week	End of 12th Week
1	147	145	144½	142½	140¾	141¼	139	138	135	133	133½	131¾	131¾
2	161	159½	160¾	157¾	156	155	153½	155	153	150	150¾	149½	151
3	152¼	153	152	150	151¼	150	149	147	148½	149¼	147½	146¾	146¾
4	165	162¼	161¾	163	162½	160¼	163½	160¼	159	158¼	158	157¼	155
5	154	151	150	151	149¾	151¼	150	148¾	148¼	148¼	148	147¾	—
6	141	138¾	137½	137¼	135	136½	136	135¼	134¾	135	133½	131¾	131¾
7	179	177	177½	175½	176½	174½	175	176	175	173½	176	173¾	175
8	157½	157½	154½	156½	154½	152	155¼	151	150	145½	147¾	144¾	—
9	196½	195¼	194	192	190½	192¾	192	191¾	189	191	189½	190½	—
10	151¾	151	147¾	145½	144½	143	—	142¼	140¼	139½	138½	138½	—
11	153½	151	152½	150	149½	149¼	148¾	150½	148	150	148	146½	145
12	160½	157	159	153½	155¼	155¾	154	151½	153½	151½	153¼	150½	—
13	141	139¼	138	138½	134¾	133½	134½	134¼	132½	130¾	128¾	129½	125½
14	135	129¾	129	126¾	—	126¼	125½	126¾	123½	124¾	122½	125½	—
15	201¼	199½	195½	193¼	189¾	191	187¼	184¼	184	182	180¾	179¾	179¾
16	148	146	144	142½	141	139	135¾	133½	132½	135¼	133½	131	130
17	197	197	196½	195¾	197¼	196¼	195½	—	196½	195¼	196	196	195¼
18	236¼	232	230½	226½	224½	225	221½	219	218¾	215¼	209½	211½	206
19	167	166½	165	165	165½	163	163	161½	161½	160½	161	158½	—
20	201	198	196¾	196¼	193¼	195½	192	192	192½	192¼	193	188	190
21	156½	149½	149¼	149¾	149¾	150	151½	150¼	148¾	151	151¼	152	149
Average	166.76	164.56	163.63	162.32	161.35	161.00	160.24	159.27	158.32	157.70	157.17	156.24	—
Av. Loss	—	2.20	0.93	1.31	0.97	0.35	0.76	0.97	0.95	0.62	0.53	0.93	—

SECOND SERIES — TABLE IV

WEEKLY WEIGHTS OF SEVEN PERSONS WHO MISSED NO TWO CONSECUTIVE WEEKS OF THE PLACEBO ROUTINE

(Except Dieters No. 3 and No. 4)

DIETER	Starting Weight	End of 1st Week	End of 2nd Week	End of 3rd Week	End of 4th Week	End of 5th Week	End of 6th Week	End of 7th Week	End of 8th Week	End of 9th Week	End of 10th Week	End of 11th Week	End of 12th Week
1	193	193¼	194½	189¼	186	185	184¾	186	183	179½	181	180½	178½
2	122	123½	121	120¼	—	120¼	—	117¼	116¾	116½	116½	115½	115½
3	205	203¼	203¼	204¼	208½	205	204¾	202¾	201¾	201	202¾	—	—
4	155¼	154½	152½	151¼	151	150½	150¼	147½	146	144½	144¾	—	—
5	138¼	137¾	136	140½	137¾	137¼	138¾	136¾	135¾	135¾	138	137	137¼
6	158½	154¾	155	157¼	155	154½	155	152½	154	154¼	—	150½	154¼
7	217½	216½	213	212¼	207½	207¼	206½	204¾	205	202	201	200	—
Average	169.93	169.07	167.89	167.86	166.57	165.68	165.54	163.93	163.18	161.93	162.34	—	—
Av. Loss	—	0.86	1.18	0.03	1.29	0.89	0.14	1.61	0.75	1.25	—0.41	—	—

participants in D gives slightly less significance to this group than the others, but the effect as to trend is nevertheless unmistakable.

Results:

As can be seen from the Tables, II, III, IV, and Graph Y, all groups lost weight. It is of interest that the weight reduction was significantly greater for the methyl cellulose tablets (C), than for either Celery (B), or Placebo (D) which were roughly the same, Graph Y.

Comment

The difficulties in ending any such experiments as we have conducted with a significant number of participants became obvious as we proceeded with these two series. In our area the population is "on the go" and many found reasons to leave the area during the study. Others became the victims of intercurrent illnesses, changs of occupation, hours of work, or even of geographic territories. In some instances, visitors upset the routine and the subjects failed to report.

However, in the instance of those who conntuied for the full 10 to 12 weeks the findings are of considerable interest. All groups lost weight even though following their own free choice of diets. The addition of celery as a "filler" appeared to influence the course favorably, and the use of a "non-filler" tablet not appreciably less so. Surprisingly enough, the methyl cellulose tablet in Group C appeared to be more effective, however slightly, than the celery-alone group. Should this indicate the use of such tablets as the method of choice for weight reduction? We do not think so.

First, the patients were happier on celery. Practically all agreed that it satisfied the hunger sensation. They enjoyed the pleasure of chewing and swallowing a gratifying substance. There were no harmful effects. Celery was alleged to have a soothing quality for "nerves", and was commented on by many. They slept better. Celery is said to have sedative, carminative, and diuretic properties.[2] Further, it is cheaper than any of the manufactured and synthetic products used, and contains measurable quantities of minerals as well as ascorbic acid, thiamin, riboflavin, and vitamin A.

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[2] Taber, Clarence W., *Cyclopedic Medical Dictionary Including a Digest of Medical Subjects, Medicine, Surgery, Nursing, Dietetics, Physical Therapy.* Philadelphia: F. A. Davis Co., 1942.

To the average individual, there is a readier acceptance for celery than for tablet medicaments, and there is less prejudice against it.

For all these reasons, these early results in the two series studied would support the use of celery as an adjunctive filler material in the dietary of a weight reduction program. However, where circumstances such as irritable colon or specific celery allergy indicate, there is ample evidence that the hydrophyllic methyl cellulose tablet does at least as well as celery if not a trifle better. We do not yet know how long this would last on a longer term of usage, and it may well be worth evaluating. It seems clear that the celery eaters enjoyed the adventure more but it is possible that circumstances of necessity or convenience might make the tablet or the tablet *and* celery program *combined* more acceptable or even more effective. It is hoped that others interested in the obesity problem will try this approach in another region of the country to see if these results can be reproduced in a larger and perhaps longer study.

Summary

1. Celery has been used as the basic filler in the otherwise free diets of obese individuals in an effort to produce significant weight reduction.

2. Control studies were made employing in the same manner a methyl cellulose hydrophyllic tablet and a placebo tablet of relatively inert, non-swelling materials.

3. All groups lost weight, the methyl cellulose tablet apparently possessing slightly more effectiveness in this study.

4. The other properties of celery appear to outweigh the slight possible advantage of the methyl cellulose tablet. These properties are pointed out; likewise some indications for the use of the tablet.

5. It is hoped that similar studies using celery will be made by other investigators in order to compare the findings of various observers working in several geographic areas.

THE POISONOUS SNAKE BITE PROBLEM IN FLORIDA

Henry M. Parrish, M.D., M.P.H.[1]
Ocala, Florida

Poisonous snakebites among human beings and domestic animals are by no means rare in the southern and southwestern portions of the United States. Porges (1953) estimated there were from 2,000 to 3,000 human snake bites annually in the United States. The importance of snake venom poisoning throughout the world has been studied by Swaroop and Grab (1954) who estimated there were between 30,000 and 40,000 deaths annually from this cause. Although there have been excellent epidemiological and clinical studies of poisonous snakebites by Wood (1954) in Virginia, by Swartzwelder (1950) in Louisiana, by Minton (1950) in Indiana by Shannon (1953) in Arizona, and by Andrews and Pollard (1953) in Florida, none of these studies have indicated the incidence or magnitude of the problem in a particular region.

There has been considerable research on the poisonous snakes of Florida by various biologists, herpetologists, naturalists, toxicologists, veterinarians; and physicians. Pollard (1956) asserted that venom research is a challenge to the various sciences. The intense interest in animal venoms is reflected by more than 4,100 references listed by Harmon and Pollard (1948) in their "*Bibliography of Animal Venoms*".

Incidence and Mortality

Allen and Neill (1957) collected records of 611 poisonous snakebites in Florida during the priod from 1934 through 1951—an average of 34 bites per year. The year with the largest number of bites was 1936 when 53 were reported. Andrews and Pollard (1953) estimated that there were 100 poisonous snakebites a year in Florida, or approximately between 3 and 5 per cent of all bites occurring in the United States. I (1957a) surveyed the incidence of snakebites among humans by sending a questionnaire to all of the practicing physicians and hospitals in Florida. There was an average of 120 poisonous snakebites a year in the state—an incidence of 3.36 per

[1] Research Fellow in Epidemiology and Biometry. Former Health Officer, Bureau of Preventable Diseases, Florida State Board of Health, Jacksonville, Florida.

100,000 population. An avarage fatality rate of 2.5 per cent was reported among 241 treated bites which occurred during 1954 and 1955. Poisonous snakebits have accounted for 47 deaths in Florida during the period from 1940 through 1955. Table 1 lists these deaths by year and race of the victim. Recently I (1957b) analyzed 71 snakebite deaths which occurred in the United States from 1950 through 1954 and found that 10 of them took place in Florida. Florida has an average death rate from snake venom poisoning of 0.65 per 1,000,000 population per year and ranks second to Arizona for the highest snakebite death rate in the United States. Human beings are not the only victims of envenomation. Parrish and Scatterday (1957) made a survey of bites among domestic animals in Florida for 1954 and 1955 by sending a questionnaire to the practicing veterinarians of the state. They reported 719 bites—an average of 360 bites a year among domestic animals. Dogs were the most frequent victims. There was a 26 per cent mortality among this group of treated animals.

TABLE 1

DEATHS RESULTING FROM POISONOUS SNAKEBITES IN FLORIDA, 1940-1955*

YEAR	WHITE	COLORED	TOTAL
1955	2	1	3
1954	2	1	3
1953	1	0	1
1952	2	0	2
1951	1	1	2
1950	3	0	3
1949	3	0	3
1948	5	0	5
1947	3	0	3
1946	4	0	4
1945	3	1	4
1944	3	0	3
1943	4	0	4
1942	2	0	2
1941	1	0	1
1940	4	0	4
TOTAL DEATHS	43	4	47

* From the Bureau of Vital Statistics, Florida State Board of Health, Jacksonville, Florida.

Poisonous snakebites among human beings in Florida were reported to occur more frequently than were 18 of the 38 reportable diseases listed in the Annual Report of the Florida State Board of Health (1955). There were more annual cases of snake venom poisoning reported than there were cases of the following diseases: brucellosis; diphtheria; bacillary dysentery; viral encephalitis; granuloma inguinale; leprosy; leptospirosis; lymphopathia venerum; malaria; meningococcal infections; opthalmia neonatorum; rabies; Rocky Mt. spotted fever; tetanus; trachoma; tularemia; typhoid fever; and typhus fever. In addition, a survey of practicing veterinarians showed there were more poisonous snakebites among domestic animals in Florida than there were cases of 13 of the 16 causes of animal diseases listed for the state during 1955. Thus, snake venom poisoning is a problem of considerable magnitude and importance in Florida.

Poisonous Snakes of Florida

Carr and Goin (1955) list 60 species of snakes as indigenous to Florida, of which, 7 species or sub-species are known to be poisonous. The poisonous snakes include: the eastern diamondback rattlesnake (*Crotalus adamanteus*); the canebrake rattlesnake (*Crotalus horridus atricaudatus*); the ground or pygmy rattlesnake (*Sistrurus miliarius barbouri*); the cottonmouth moccasin (*Ancistrodon piscivorus piscivorus*); the copperhead moccasin (*Ancistrodon contortrix contortrix*); and the coral snakes (*Micrurus fulvius fulvius*); and (*Micrurus fulvius barbouri*). The eastern diamondback rattlesnakes are by far the deadliest snakes found in Florida for, by virtue of their size, they produce the most venom. Approximately 85 per cent of the deaths from snakebites in Florida have resulted from rattlesnake bites. The cottonmouth moccasin is the second most deadly offender. Few deaths result from bites by pygmy rattlesnakes, copperhead moccasins and coral snakes. Indeed, only one of the 71 deaths in the United States during the period from 1950-1954 resulted from a coral snake bite. This probably resulted from the fact that coral snakes are much less aggressive than the pit vipers, they are found in a limited geographical area, and they have short fangs making it necessary for them to chew on the victim to inject venom. There are relatively few copperhead moccasin bites in Florida, since they are found only in a limited section of the northern part of the state. Of the poisonous snakebites in Florida,

rattlesnakes accounted for about 60 per cent of the bites, cottonmouth moccasins for 20 per cent, copperhead moccasins for 2 per cent, coral snakes for 2 per cent, and the species was not identified for the remainder of the bites. Of interest is an occasional cobra bite resulting from milking imported snakes whose venom is used for medical purposes.

Venoms

The venom of the pit vipers (rattlesnakes, copperheads and cottonmouth moccasins) is primarily hematoxic in action; whereas the venom of coral snakes more closely resembles that of cobras and is primarily neurotoxic in action. Kellaway (1949) has attributed the toxins in snake venoms to proteolytic enzymes, phosphatidases, and neurotoxins. The venom of pit vipers is disseminated by means of powerful "spreading factors", including hyaluronidase. Most of the venom is spread through the tissue spaces and lymphatic vessels. Phosphatidases act on the heart and circulation and also produce hemolysis of the red blood cells. Proteolytic enzymes produce local tissue damage and cause destruction of the capillary vessels. The neurotoxins poison the central nervous system and may produce motor and respiratory paralysis. Histamine is released by the body following envenomation, and it may lead to a profound drop in the patient's blood pressure. Fidler *et al.* (1940) listed the following pathological changes resulting from pit viper venoms: local destruction of the tissues and capillary endothelium; leakage of blood and serum into the tissue spaces; shock and hypotension from blood loss and histamine effects; and anemia produced by hemolysis of red blood cells. With severe venom poisoning there may be involvement of the heart, kidneys, intestines and brain. Gangrene, infection and tissue slough are important local complications. Permanent atrophy and functional disuse of an extremity or digit are by no means rare sequelae of poisonous snakebites. Parrish *et al.* (1956) found enteric and coliform organisms in the mouths and venom glands of North American pit vipers. Snake bite wounds are contaminated, venom-laden, necrotic, anaerobic, puncture wounds which provide an excellent medium for bacterial growth.

Demographical and Climatological Factors

The largest number of poisonous snakebites in Florida occurred in the heavily populated areas of the state. Figure 1 shows the

Figure 1. Geographical distribution of poisonous snakebites in Florida 1954 and 1955.

geographical distribution of bites among humans for 1954 and 1955. This geographical distribution of bites is based on the place where treatment was administered. I feel that this distribution is fairly representative of the locality where the bite occurred except in the case of bites in less populated counties where there are less adequate medical facilities. In this instance, bites are referred to hospitals in adjacent counties. The counties reporting the largest number of bites were: Hillsborough—22; Pinellas—20; Dade—16; Palm Beach—15; Marion—14; Duval—13; Broward—13; Leon—12; Lake—11; and Orange—10. With the exception of Marion, Lake and Leon counties, all of the counties with over 10 bites for the two year period had a population of over 100,000 persons. Also of interest is that poisonous snakebites occurred in all portions of the

state. These findings suggest that the number of population at risk is an important factor in the distribution of bites.

Although usually the heavily populated counties reported the most cases of envenomation, Table 2 indicates that they don't necessarily have the highest incidence rates per 100,000 population. Of the counties reporting, more than 10 bites for the two year period, the highest incidence rates were found for the following: Marion—15.55; Lake—12.21; Leon—10.0; and Palm Beach—4.77. Marion county had the highest incidence rate, but there are two contributing factors which account for this high rate: (1) approximately half of the cases were employees of Ross Allen's Reptile Institute where venom is routinely extracted for medical and research purposes; and (2) cases were referred to the Marion county hospital for treatment from adjacent smaller counties which have less adequate medical facilities.

Neill (personal communication) has found that, " . . . throughout much of Florida, the eastern diamondback rattlesnake (*Crotalus adamanteus*) is far less common in wild, remote places than in areas of rural and suburban settlement. It is most abundant in regions where scattered farms, fields and houses alternate with strips and patches of woods. This conclusion is based not only on personal experience but on the experience of hundreds of people who catch rattlesnakes for sale to the Ross Allen Reptile Institute."

Table 3 lists the number of poisonous snakebites among human beings and domestic animals in Florida by the month of occurrence. The month snakebite accidents took place among domestic animals parallels that of bites among human beings. Few bites occurred during the winter months. The number of bites gradually increased beginning in April and reached a peak during August and September. These are the periods of greatest out-of-doors exposure and recreational activity for man. Contrary to popular opinion, most snakebites among dogs do not occur during the hunting season. I can offer no theory to explain the seasonal distribution of bites among animals. Swartzwelder (1950) felt that this seasonal distribution of bites among humans possibly was due to the inactivity of snakes during the colder months as well as to mans' greater exposure during the warmer months. Neill (1955) reported that more eastern diamondback rattlesnakes are found during the winter months in Florida and that their period of greatest activity was during February. He stated that, " . . . during the hot summer

TABLE 2

INCIDENCE OF POISONOUS SNAKEBITES IN FLORIDA BY SELECTED COUNTIES

County	Estimated Pop. 1955*	No. Bites per Year	Rate per 100,000
Dade	691,244	8.0	1.16
Duval	396,502	6.5	1.64
Hillsborough	323,023	11.0	3.40
Pinellas	217,066	10.0	4.61
Orange	176,402	5.0	2.83
Broward	159,052	6.5	4.09
Escambia	157,385	2.5	1.59
Palm Beach	157,086	7.5	4.77
Polk	156,167	4.0	2.56
Leon	59,995	6.0	10.00
Lake	45,055	5.5	12.21
Marion	45,010	7.0	15.55
St. Johns	29,378	2.5	8.51
Lee	31,142	1.5	4.82
Nassau	15,131	1.0	6.61
Walton	15,116	1.0	6.62
Gulf	9,444	1.0	10.59
Okeechobee	4,188	0.5	11.94

* Annual Report, Florida State Board of Health, Jacksonville, 1955. p. 30.

TABLE 3

MONTHS POISONOUS SNAKEBITES OCCURRED AMONG HUMAN BEINGS AND DOMESTIC ANIMALS IN FLORIDA, 1954-55

	Number of Bites		
Month	Human beings	Domestic animals*	Total
January	7	6	13
February	6	4	10
March	13	16	29
April	25	31	56
May	27	43	70
June	28	48	76
July	35	44	79
August	33	54	87
September	38	65	103
October	16	34	50
November	7	18	25
December	6	9	15
Total	241	372	613

* Data on animal bites limited to 1955.

months few diamondbacks are found. Yet our figures on snakebite incidence reveal that diamondback bites reach a peak in summer, and are at a low in the winter. Clearly, then, the season incidence of diamondback bite in Florida reflects human activity; in the summer the woods and fields are visited by many people." Thus human activity as well as the habits of snakes are determinants in the seasonal incidence of bites.

Host Factors

Of 241 human victims of envenomation in Florida during 1954 and 1955, 179 were males and 62 were females. That males were more frequently bitten than females probably reflects their increased risk due to types of occupation and recreation. There were 199 bites among white persons, 41 among Negroes, and one in an Indian. This racial difference is not remarkable since there are approximately four white persons for every Negro in the state and there were five bites among whites for every bite in a Negro. Indians constitute a minority group in the state, hence the small number of bites among this group. These data may be misleading however in that this group probably does not seek medical treatment but uses tribal medicines. Forty-nine per cent (119) of the bites occurred in young people less than 20 years of age. The natural curiosity of children and their lack of knowledge about the danger of snakes probably attributed to the high incidence in this age group.

The occupation of the snakebite victims were as follows: schoolchildren—68; pre-school children—48; housewives, especially those who kept gardens or lived in rural areas—23; construction workers—12; and professional or amateur snake collectors—10. Only 7 members of the Armed Forces were bitten. These data indicate that persons engaged in out-of-doors activities have an increased risk to snake venom poisoning.

The activity of the victim at the time of a bite is obviously a more important factor than the victim's occupation. Although the activity of the patient at the time of the envenomation was not stated in 82 instances, it is of significance that 43 children were bitten while playing in the yard or in close proximity to their places of residence. Many of these bites might have been prevented if they had been wearing shoes and long trousers. Twenty-three persons were bitten

while handling a poisonous snake. One of the easiest ways to be snakebitten is for an inexperienced (or oftentimes experienced) person to pick up a poisonous snake. Of the persons reported bitten while engaged in recreation, 17 were fishing, 2 were swimming and 2 were hunting. These facts may come as a surprise to many hunters.

TABLE 4

ANATOMICAL LOCATION OF POISONOUS SNAKEBITES AMONG HUMANS AND DOMESTIC ANIMALS IN FLORIDA 1954 AND 1955

SITE OF BITE	HUMAN No. Bites	%	DOMESTIC ANIMALS No. Bites	%
Head and Face	1	0.4	291	40.5
Arm or foreleg	16	6.6	111	15.4
Shoulder	2	0.8	72	10.0
Neck	0	—	50	6.9
Leg or hindleg	60	25.0	43	6.0
Chest	0	—	38	5.4
Fingers, hand or forepaw	89	36.9	13	1.8
Toes, foot or hindpaw	53	21.9	13	1.8
Abdomen	0	—	15	2.0
Tail	0	—	4	0.6
Buttock	1	0.4	—	—
Not Stated	19	8.0	69	9.6
Total	241	100.0	719	100.0

There are distinct differences between snakebites among human beings and snakebites among domestic animals. One of the more notable differences is the anatomical site of the bite. Table 4 lists the anatomical location of poisonous snakebites among humans and domestic animals. In contrast to humans in whom more than 90 per cent of snakebites occur on the extremities, domestic animals are more frequently bitten on the head, shoulder and neck. In general, bites on the face or trunk are more serious since the venom is more rapidly absorbed into the general circulation and these sites do not lend themselves readily to the use of a tourniquet and surgical therapy. Other factors which tend to make snake venom poisoning more serious in animals are the delay in treatment after the bite and the small size of the animals which increases the ratio of the units of venom injected to the units of body weight.

Diagnosis

Frequently a patient will bring the offending reptile to the physician when reporting for treatment. Pit vipers may be identified by a deep pit which is located between the eye and nostril. The pupil of all pit vipers is elliptical in shape, in contrast to the round pupil of non-poisonous snakes. They have two well developed fangs located on the upper jaw. In addition, the rattlesnakes are recognized by rattles which are attached to the tail. The other pit vipers do not have rattles. (See Figure 2 which demonstrates the diagnostic features of pit vipers.)

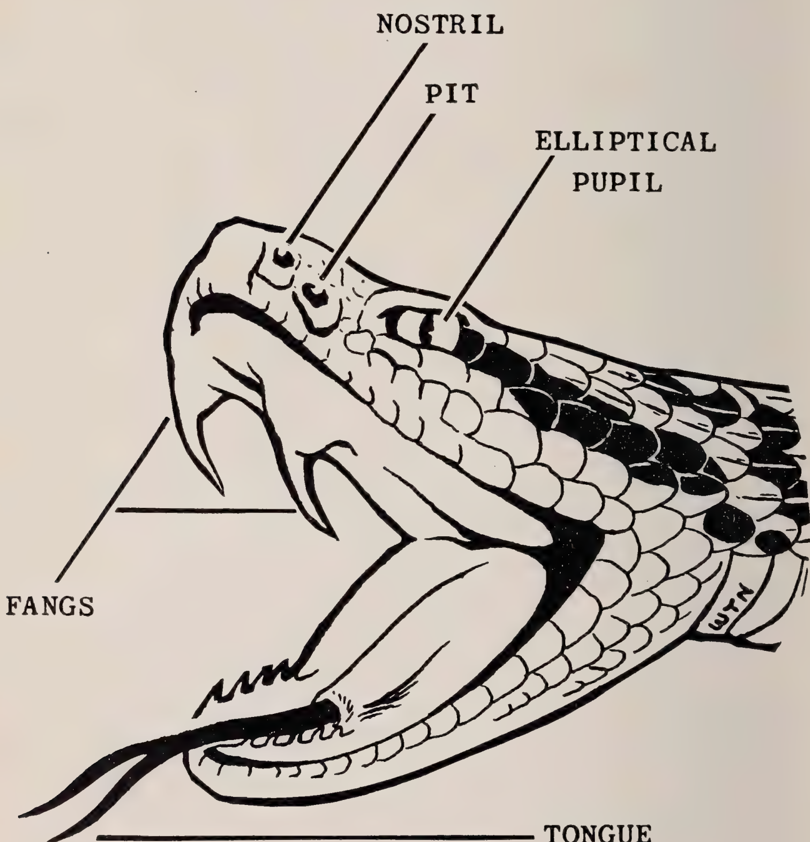

Figure 2. Head of a pit viper, showing diagnostic features.

Coral snakes are brilliantly colored snakes, rarely over three feet in length, which have broad rings of scarlet and black separated by narrow rings of yellow. An important fact to remember is that the snout is always black. To remember the phrase "red next to yellow will kill a feller" is also helpful in identifying them, since several non-poisonous snakes closely resemble the coral snakes.

Pit vipers account for 96 to 98 per cent of all poisonous snakebites in Florida; therefore, I will confine my remarks to this group of snakes. Since pit vipers possess two well developed fangs, a pit viper wound usually has one or two (occasionally three or four, if new fangs are growing in to replace old ones) puncture wounds which are surrounded by an area of redness and swelling. If the fangs glanced off the bitten area, only a scratch will be seen. In this case, there will be less surrounding erythema and swelling. An important fact worth remembering is that a poisonous snake may bite a person without injecting enough venom to produce clinical signs and symptoms of envenomation. If the bite was a serious one the swelling will progress rapidly. Pope and Perkins (1944) experimentally differentiated the bite patterns of poisonous snakes from those of non-poisonous snakes. They noted that poisonous snakes' bites may leave teeth impressions in addition to those made by the fangs. However, non-poisonous snakes' bites never leave large fang puncture wounds. Also, practically no swelling results from the bite of a non-poisonous snake. If in doubt about the diagnosis of a poisonous snakebite, it is better to observe the bite site for a period of time rather than to vigorously treat a patient for a bite which later proves to be of non-poisonous origin. Watt and Pollard (1954), Watt, Parrish and Pollard (1956) and Andrews and Pollard (1953) have carefully described the signs and symptoms resulting from bites by the venomous snakes of Florida. I have noticed that local pain at the injection site is a symptom of pit viper poisoning and occurs in about 80 to 90 per cent of the cases. The pain is usually intense and burning in character. However, occasional severe bites may not prove painful for the neurotoxic fraction of the venom produces numbness and tingling which alters the pain response. This is especially true of severe bites by the eastern diamondback rattlesnake. Other symptoms which may be present are: shock; weakness; nausea; vomiting; numbness, especially in the extremities and circumoral areas; difficulty in breathing; muscular twitching and motor paralysis. (Refer to Table

5 for the differential diagnosis between poisonous and non-poisonous snakebites.)

TABLE 5

DIFFERENTIAL DIAGNOSIS OF POISONOUS AND NON-POISONOUS SNAKEBITES

Characteristic		Poisonous	Non-poisonous
Fang puncture		Present	absent
Tooth marks other than fangs		may be present	present
Pain		usually intense	minimal
Swelling or edema surrounding bite site		extensive and progressive	none to very minimal
Erythema surrounding bite site		extensive and progressive	none to minimal
Shock		may be present	absent
Nausea and vomiting		may be present	absent
Muscular twitching		may be present	absent
Coma		may be present	absent
Motor or respiratory paralysis		may be present	absent
Numbness and parasthesias		may be present	absent
SEQUELAE	infection	common	rare
	gangrene	common	none
	sloughing	common	none
	atrophy	common	none
	anemia	common	none

Some of the factors which determine the severity of a poisonous snakebite are: the age, weight and general condition of the patient; how soon treatment is instituted after a bite; the location of the bite; the nature of the bite (a glancing scratch as opposed to deep impregnation of the venom); and the toxicity of the venom of the specific snake. In general, the amount of venom a snake produces is in direct proportion to its size; however, the venom of small and young snakes is just as toxic as that of larger snakes. Bites on the face and trunk are more dangerous than bites on the extremities. Also, envenomation is always more serious in small children as the ratio of the units of venom injected to the units of body weight is much greater. Poisonous snake bites are poorly tolerated by older individuals who have other physical ailments and less general resistance.

Wood, Hoback and Green (1955) have devised an excellent clinical classification of the severity of pit viper envenomation based on the signs and symptoms and the patient's course during the first 12 hours of hospitalization. They classify bites as *Grade I*—

Minimal Venenation if there is evidence of a fang wound with surrounding swelling not extending for more than a few inches, and without the presence of systemic symptoms. *Grade II—Moderate Venenation* includes those cases with the signs of Grade I but with progressive swelling which involves about half the distance between the bite site and the trunk. Nausea, vomiting and giddiness are usually present as are palpable regional lymph nodes and a low grade fever for several days. *Grade III—Severe Venenation* includes patients whose early course may resemble those of Grade I and II but the intoxication progresses rapidly. The patients may experience hypotension and shock within a few minutes following the bite. The swelling is more extensive and in 12 hours advances to or involves part of the trunk. The pulse is often rapid and thready and the temperature is subnormal. Petechiae are frequently generalized in distribution. In addition, I have observed that these patients frequently are comatose and have either localized or generalized muscular twitching. Perhaps a *Grade O—Poisonous Snakebite Without Venenation* should be added to include those patients either bitten or scratched by poisonous snakes' fangs but who do not exhibit local swelling and pain or other signs and symptoms of clinical venenation. Parrish and Pollard (1957) classified 60 poisonous snakebites occurring among 12 individuals with repeated poisonous snakebites and found that of 15 instances of Grade III—severe venenation, 9 were caused by rattlesnakes (*Crotalus sp.*) 4 were caused by cottonmouth moccasins, and 2 were produced by copperhead moccasins. Thus, pygmy rattlesnakes and copperhead moccasins rarely produce severe venenation.

Treatment

The treatment of snake venom poisoning may be divided into two phases: (1) first aid treatment; and (2) hospital treatment. The rationale for treatment is based on the following measures:

First Aid

A. Prevent or retard venom absorption locally
B. Remove the venom locally

Hospital Treatment

A. Neutralize the venom locally
B. Neutralize the venom systemically

C. Increase elimination of the venom systemically (theoretical)

D. Prevent local complications

E. Prevent systemic complications

First Aid Treatment—Before administering first aid treatment these questions should be answered: Has this patient been snake-bitten, and, if so, was it by a poisonous snake? Is there a break in the skin or fang marks in the bitten area? Does the patient complain of pain, and is there evidence of local swelling and redness? *Do not make the mistake of applying drastic first aid measures to a patient who shows no objective evidence of venom poisoning.*

A. The presently accepted first aid treatment includes immediate application of a *constricting band* several inches above the bite site. The term "tourniquet" has been purposely avoided because the constricting band should be applied only tight enough to occlude the *superficial* venous and lymphatic circulation. A word of caution —do not apply the band tight enough to occlude the arterial blood flow, and be sure to release the band every 10 to 15 minutes for a period of 2 or 3 minutes. Advance the band up the extremity as the swelling progresses so as to keep just ahead of the swelling. Intermittent use of a constricting band should be continued until the patient is seen by a physician. The purpose of the constricting band is to impede the spread of venom until it can be mechanically removed or neutralized. Pope and Peterson (1946) have shown that animals treated with a tourniquet alone survive longer than those with no treatment.

B. In addition to a constricting band, small superficial cruciate *incisions* should be made over the fang marks; they should be about ¼ of an inch long and ⅛ to ¼ of an inch deep (just deep enough to draw blood). Do not mutilate a patient with deep stab wounds. Often the results of drastic first aid treatment prove to be worse than the snakebite. Additional incisions may be spaced two or three inches apart as the venom spreads. Very little pain results from these incisions owing to the numbing effects of the venom. If the incisions are properly made there is practically no danger of injuring a major blood vessel or nerve. *Suction* should be applied to the incisions to remove the venom. Suction cups provided with Cutter or Becton-Dickinson snakebite kits are adequate for this

purpose. If suction cups are not available, oral suction may be used. There is very little chance of becoming intoxicated from swallowing venom, as it is inactivated in the gastro-intestinal tract. To prove this, Allen (1949) swallowed 4 cc. of cottonmouth moccasin venom, and experienced no unusually toxic effects. However, oral suction should not be used in the presence of extensive ulcerations of the mouth. Suction should be applied for several hours depending on the seriousness of the bite. This treatment, consisting of a constricting band with incision and suction, is known as the "Jackson first aid treatment of snakebite". Jackson (1928, 1929) demonstrated survival of dogs poisoned with 4 MLD's (minimum lethal dose) of venom when treated in this manner. He showed that the bloody fluid obtained from suction cups when injected into normal dogs contained enough venom and toxic products to kill the animals.

The victim should be constantly reassured because the emotional shock and fear accompanying snakebite are often out of proportion to the severity of the bite. Do not get excited yourself for most patients who die from envenomation do so from 12 to 48 hours after the bite. With immediate first aid and proper medical treatment the mortality from venom poisoning should be less than two per cent. Keep the patient quiet, do not give him stimulants or alcohol and get him to a hospital or physician as soon as possible. The sooner a patient receives medical treatment, the better his chances are for survival.

Hospital Treatment—When the patient arrives at the hospital, the physician may want to make additional incisions for suction depending on the severity of the bite. Suction should be maintained constantly for about 2 hours. If the bite was Grade II or Grade III venenation, suction should be maintained intermittently for 2 to 6 hours. The suction cups are alternated: 15 minutes on, then 15 minutes off as long as desired. During the interim the wounds should be covered with warm saline or magnesium sulfate compresses. The constricting band should not be used after the swelling has spread up an extremity to the trunk. This usually takes two or three hours. Parrish and Gardner (1956) have discussed the nursing care of snakebite patients in detail, including the use of suction cups.

A. Although many drugs and chemicals have been tested for treating snake venom poisoning, none of them has been shown to

be of specific value. Proper snakebite treatment utilizes a combination of medical and surgical measures. The following drugs are important adjuvant remedies. Epinephrine hydrochloride, 3 to 5 minims of a 1:1000 solution, is of value in combating the shock and hypotension which invariably follow severe bites. Intravenous whole blood, saline and plasma are also useful for this purpose. Calcium gluconate solution may help prevent hemolysis produced by pit viper venom. Demerol, 75 to 100 mg., may be given to alleviate pain which is often intense.

B. Watt, Parrish and Pollard (1956) recommend "the 3 A's" (antivenin, antibiotics, and antitoxin), in addition to a constricting band with incision and suction, for treating all serious snakebites. A new, potent antivenin (Antivenin Crotalidae Polyvalent; Wyeth) has been developed which offers protection against the venom of all North American poisonous snakes except the coral snake. The manufacturers recommend one to five amopules (10 to 50 cc.) depending on the severity of the venenation. Ten to twenty cc. may be injected around the bite site and the remainder is injected into the muscles of the involved extremity. However, antivenin should not be injected into a finger or toe, as the additional fluid may embarrass the already impaired circulation and produce gangrene. Personally, I do not feel that cases of Grade I—Minimal Venenation need antivenin; however, it should be administered to patients with Grade II and Grade III Venenation. All patients should be skin-tested for sensitivity to horse serum before antivenin is given, since antivenin is made by hyperimmunizing horses with snake venoms. Pathogenic bacteria, including tetanus and gas gangrene organisms, have isolated in snakes' venom and mouths, therefore tetanus antitoxin or toxoid and gas gangrene antitoxin should be given to the patient. In addition, a wide spectrum antibiotic should be given to prevent bacterial infections. Penicillin alone is of little value because of the predominance of gram negative bacteria.

C. There has been a recent tendency in medical and veterinary practice to rely on ACTH, cortisone and antihistamine drugs as the primary treatment of snake venom poisoning; however, Schottler (1954) did not find any of them of specific value experimentally. Cortisone does not seem to prevent death from envenomation, but it does diminish the pain accompanying severe venenation and it may prevent or lessen any allergic reactions produced by horse

serum from antivenin. A word of caution about the popular "L-C Method" (ligature and cryotherapy) of treating snakebites as advocated by Stahnke (1953). This method involves the use of a tight ligature, ethyl chloride and ice packs. While theoretically freezing the tissues should lessen the enzymatic activity of venom and retard its spread, it has not been proved a reliable form of treatment. Allen (1939) found that as soon as the ice is removed the venom spreads into the body and the frozen area is subject to necrotic degeneration and sloughing. Until there is better evidence that cryotherapy is of some value and that it is not harmful, I feel it should be rejected in toto.

Summary

1. Poisonous snakebites are an important medical problem in Florida since this state ranks second to Arizona for the highest annual snakebite death rate. From 1940 to 1955 there were 47 deaths from snake venom poisoning in the state. An average of 120 human beings and 360 domestic animals are snakebitten each year in Florida. Two and one half per cent of the human cases and 26 per cent of the domestic animal cases terminate fatally.

2. Although the heavily populated areas of the state have the largest number of snakebites annually, the incidence of bites per 100,000 population is highest in Marion, Lake, Leon and Palm Beach counties. Most of the bites occur during the warmer months beginning in April and reaching a peak during August and September.

3. Males are the victims of snakebite accidents approximately three times more often than females. Forty-nine per cent of the bites occurred among young people less than 20 years of age. Persons working in out-of-doors occupations have a greater chance of being bitten. Human beings are more frequently bitten on an extremity; whereas domestic animals are more often bitten on the head, neck and shoulders.

4. At least one species of each of the four kinds of poisonous snakes found in the United States is known to inhabit Florida; they are the rattlesnake, the copperhead moccasin, the cottonmouth moccasin, and the coral snake. Rattlesnakes accounted for 60 per cent of all bites, and most of the snakebite deaths. Methods of distinguishing between poisonous and non-poisonous snakes is given in detail.

5. The first aid and medical treatment of snakebites is discussed and "the 3 A's" (antivenin, antibiotics and antitoxin), in addition to a constricting band with incision and suction, are recommended for treating snake venom poisoning.

Acknowledgement

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CHANGES IN BOTTOM TOPOGRAPHY OFF ALLIGATOR HARBOR SINCE 1889 [1]

HERBERT CURL, JR. [2]
Florida State University

In the course of hydrographic studies in the region of Alligator Harbor, during 1954-1956, a single long transect was made of the bottom topography. Since this region has been little investigated, geologically, the resulting profile is of some interest with regard to sediment transportation and wave energies.

Alligator Harbor, itself, is located at 29°59.9′N. and 84°22.9′W. in Franklin Co., Florida. It adjoins the Gulf of Mexico proper and, together with the islands enclosing St. George Sound, forms the northern boundary of the wide west coast continental shelf of Florida. The hydrography of the Alligator Harbor region has been described in some detail by Olson (1955) and Curl (1956).

The continental shelf immediately south of Alligator Harbor consists of Eocene deposits (Tampa limestone) lying at a depth of five hundred feet below mean sea level and covered with unconsolidated recent sediments of alochthonous origin (Cooke 1945). These sediments include quartz sand mixed locally with shells and shell debris. Coral heads and coral patches are scattered below the thirty fathom line (Lynch 1954). Both sand and silt are being deposited on tidal flats, and flood plains at river mouths. Rock exposures of Tampa limestone stop abruptly at Ochlochnee Bay, which marks the eastern boundary of the Apalachicola Delta, although there is some exposure at St. Theresa, Franklin Co.

In August 1955 a fathogram profile was run for a distance of 25 miles in a south-south easterly direction (170°) roughly paralleling the Duer Channel (Fig. 1). This profile may be compared with the equilibrium profiles of the continental shelf bottom prepared by Price (1954, 1955) (Fig. 2). The two sector curves are from Price's data. Sector V is representative of moderate energy shorelines as found on the west coast of Florida from Cape Romano to Anclote Keys, where limestone bottoms prevail. Sector VII is representative

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[1] Contribution No. 87 from the Oceanographich Institute, Florida State University.

[2] The author's present address is: Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

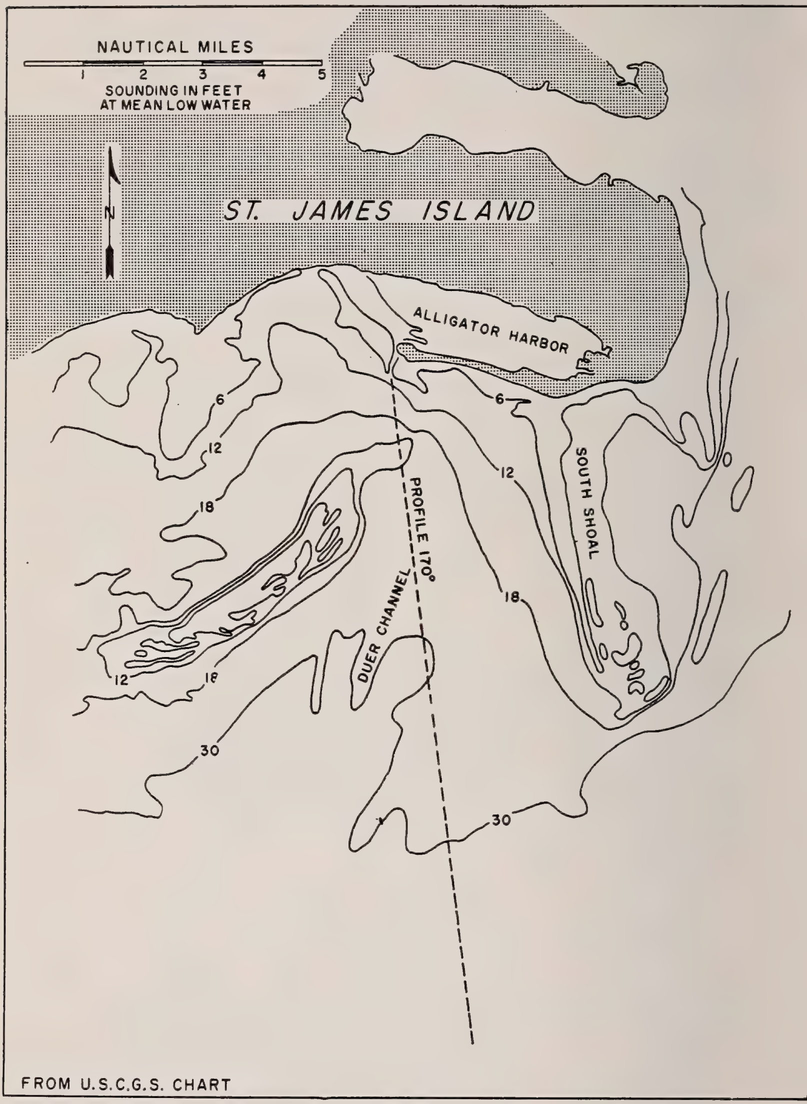

Figure 1. Depth contours and direction of bottom profile south of Alligator Harbor. From USCGS Chart No. 1261.

of high energy profiles off the southwest Texas coast. These are predominantly sand and mud bottoms scoured to the wave base. The smooth curve drawn for the entire Duer Channel profile falls halfway between the high and moderate energy profiles near shore and approaches the high energy profile at about fifteen miles seaward. There is one notable departure from the smooth curve, six miles from shore, where a distinct "mound" appears. This mound is located abreast the southern terminus of South Shoal. If this feature is compared with the soundings taken from USCGS Chart 1261 (Fig. 2), it will be noted that the shoal previously had a much smoother descent and extended five more miles to seaward. About fifteen feet of sediment appear to have been removed. The chart used (1940 edition) was actually surveyed for in 1872-1889. Apparently a great amount of sediment has been displaced at some time during the intervening sixty-six years.

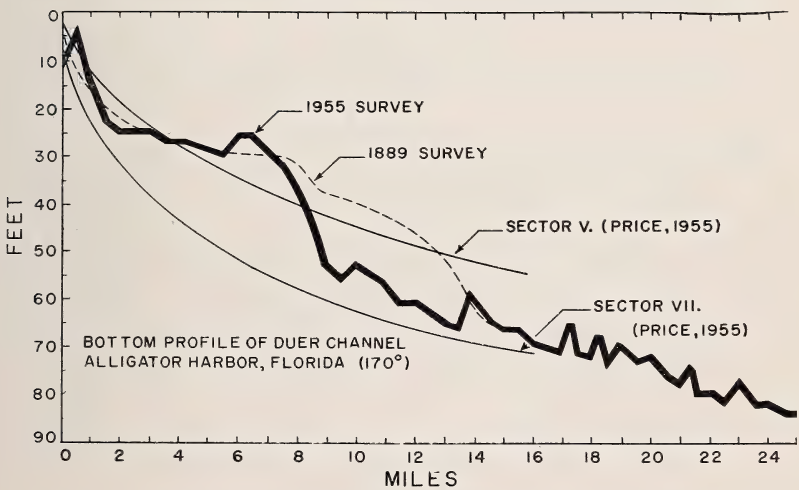

Figure 2. Bottom profile south of Alligator Harbor and comparative energy profiles.

In this locality, at least, the inshore shelf bottom profile appears to be transforming from one of moderate energy to one of high energy. It cannot be ascertained from these two profiles whether this process is a continuing one or occurred over a short period of time with subsequent stability. The bottom deposits in the zone of removal consist of 90% quartz sand with a particle size range of

0.5-1.0 mm. These sediments are large-grained and well-sorted, indicating strong current conditions. Hurricane tides appear in this section of the Gulf of Mexico periodically and there is evidence of a strong westward long-shore current (Curl 1956). Clearly, the pressing need is for repeated detailed topographic surveys of the entire locality. Since the rate of change is not known, a high frequency of observations, particularly following storms, would be desirable initially.

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THE STATUS OF THE NUTRIA IN FLORIDA [1]

JAMES V. GRIFFO, JR.
University of Florida

The nutria (*Myocastor coypus*), a South American rodent introduced into the United States, has been the object of considerable contention in the southern and western parts of the country. Well able to acclimate itself in North America, especially in southern marshy areas, this species has raised havoc with aquatic vegetation and farm crops in addition to competing with the muskrat and waterfowl for food. Only a few parasites and predators of the nutria are known. F. C. DuBois, (*in litt.*) reports that occasionally they suffer from screwworms. According to Hodgson (1949) they may be susceptible to coccidiosis, and the young are sometimes killed and eaten by rats. Thus, without any effective natural control these animals have been able to increase their numbers and spread to such an alarming degree in some parts of the United States that efforts, lasting as late as the 1930's, failed, and numerous animals (Presnall, 1957).

Nutria were first introduced into the United States in 1899, when a mature male and three females were imported by Will Frakes of Elizabeth Lake, California (Hodgson, 1949). Other importations were received in western United States during the early 1900's as part of an attempt to establish a nutria fur industry. These early efforts, lasting as late as the 1930's, failed, and numerous animals were released in the wild when breeding became unprofitable. Feral colonies were thus established in western United States.

In the late 1930's E. A. McIlhenny enclosed six pairs of nutria on Avery Island, Louisiana, in an attempt to develop a nutria farm. Within two years some of the animals had managed to escape and establish themselves in the Louisiana marshes (Dozier, 1951). In 1940 a hurricane in this same area washed the remaining nutria (150 animals) off Avery Island. Survivors reaching the mainland added to the existing population, thus giving nutria a firm foothold in Louisiana (Anonymous, 1955). Subsequently the animals multiplied and spread to the lakes, rivers, bayous and marshes of Louisiana until at the present time their population is estimated to be well over one million in that state alone (Sampson, 1957). Impor-

[1] A contribution from The Department of Biology.

tations, releases and immigrations contributed to the spread of nutria to Texas, Georgia, Mississippi and Alabama. In recent years feral nutria have been reported in Florida (Anonymous, 1955).

This study was made in an attempt to assess the present status of nutria in Florida. Since the climate and vegetation of this state appear to be well suited to the growth and reproduction of nutria there is reason to believe that the species may flourish here if it is successful in establishing a foothold. Knowledge of the present status of nutria in the state may be valuable as a basis for analyzing future trends in distribution and population.

Table 1. Distribution of Nutria Farms in Florida.

Locality	Number of Animals
Alachua County	2 (2)
Gainesville	
Dade County	
Miami*	?
DeSoto County	
Arcadia*	18
Escambia County	
Pensacola	15
Hillsborough County	
Tampa*	4
Tampa*	6 (?)
Plant City*	4
Lake County	
Tavares*	4
Lee County	
Ft. Myers*	?
Manatee County	
Bradenton*	?
Marion County	
Ocala*	6
Ocala*	12
Ocala*	2
Silver Springs	2
Summerfield	200 (?)
Orange County	
Orlando*	2
Pasco County	
Dade City*	2
Putnam County	
East Palatka*	50 (1)
Sarasota County	
Sarasota*	2
Taylor County	
Perry	?

? Exact numbers unknown.
( ) Indicates the number of escapees.
* Indicates membership in a nutria ranching association.

Information on nutria in Florida has been obtained from several sources. Various officials of the Florida Game and Fresh Water Fish Commission have provided information on apparently feral nutria caught by professional trappers and sight records reported by game wardens. The nutria ranching associations in the state have been very cooperative by providing the locations of nutria farms and the number of animals kept by the individual owners. Some information was obtained from newspapers which have given the nutria considerable publicity in recent months. Specimens in the University of Florida mammal collection provided additional records.

Reports of nutria in Florida consist of purposely released animals, feral nutria, i.e., animals which have no known origin in the state, farm raised animals and nutria which have managed to escape from farms. Nutria have been reported from 26 localities in at least 23 counties in the state. Several communities such as Tampa and Ocala have two and three farms respectively (Table 1). The majority of the farms are at present located in central and west central Florida. The estimated population is between 300 and 500 animals, though this figure may be somewhat conservative since feral nutria populations in northwest Florida may be higher than available information indicates.

Feral Records

Feral nutria with one exception appear to be restricted at present in the counties along the northwest and west central coasts of Florida (Figure 1).

Seven records considered to be feral nutria have been reported in Florida. These reports indicate feral nutria present at North Choctawhatchee Bay, East Choctawhatchee Bay, the mouth of the Apalachicola River, the mouth of the Suwannee River, Cedar Keys, Otter Spring Run (Gilchrist County), and the Hillsborough River (Figure 1). The record from the Hillsborough River is based on a description of a skin which leaves little doubt that the animal was a nutria. Since the specimen was collected prior to the existence of any nutria farms in the area it is assumed to represent a feral animal. The record from Cedar Keys is a sight record of an animal which fits the description of a nutria. The skeleton of a nutria found at Otter Spring Run, Gilchrist County, is deposited in the University of Florida mammal collection. Whether the skeleton

represents a feral animal or an escapee is actually unknown, although it seems likely that feral nutria may have reached Gilchrist County in their immigration into Florida, particularly since the nearest nutria ranch is about 40 miles distant. Apparently a small

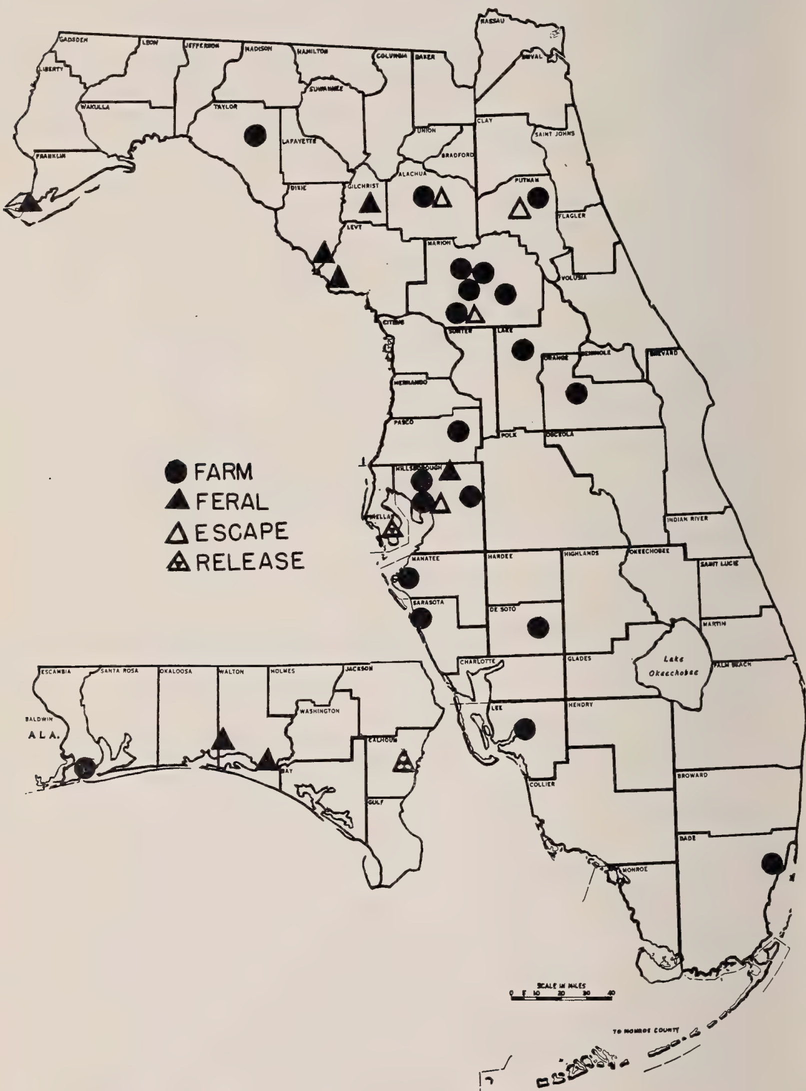

Figure 1. Distribution of nutria in Florida.

population exists in Choctawhatchee Bay since small numbers of nutria have been trapped in that vicinity (E. Timmons, *in litt.*). The occurrence of nutria on the Apalachicola and Suwannee Rivers is based on reliable reports (E. Timmons, *in litt.*). The feral records from northwest Florida are most likely animals which have established themselves in the wetlands after wandering from Louisiana to the Mobile Delta of Alabama and rivers of southwest Georgia. The nutria reported from the northwest and west-central regions of Florida (Anonymous, 1955) are unquestionably feral animals since the known nutria release in this area took place in March, 1957. Also, it is improbable that the animals are escapees since the known nutria farms at Pensacola and Perry were not established until recently. With one exception the feral reports are confined to coastal regions in the vicinity of large rivers. Apparently the animals are immigrating southward along the coastline where rivers and marshes are serving as avenues of distribution.

Releases

Organized releases of nutria are known to have taken place at two localities in Florida. At Blountstown a release of four males and eight females was made in March, 1957. The animals were turned loose in Lake Hilda as a measure to control aquatic vegetation which has overgrown the lake. According to E. B. Chamberlain (*in litt.*) a small release of nutria has been made on private land near St. Petersburg. No other information is available but more than likely these animals were stocked in an effort to clear up an overgrown lake. Information provided by A. S. Stephens (*in litt.*) suggests the possibility of a third release somewhere in the state. According to Stephens, a truckload of nutria appeared at East Palatka in June 1957. Apparently some community had purchased the animals for release although the ultimate destination of the shipment was not learned.

Nutria Farms and Escapes

There are at present 20 known nutria ranchers in Florida raising between 300-400 animals. Fifteen of these ranchers belong to some type of nutria ranching association (Table 1). More than likely there are others who could have purchased their stock from out-of-state sources and therefore are unknown to any of the Florida dis-

tributors. The 20 ranchers reported in this paper are now actively raising nutria for pelts while there are a considerable number of interested people awaiting delivery of breeding stock. Ranchers who are members of ranching associations are required to keep their animals in escape-proof pens. There are, however, several ranchers who do not belong to any association and therefore raise the animals as they see fit. Generally it is from this type of ranch that animals are known to have escaped. One such farm located at Summerfield now has over 200 animals which have all been raised from a single pair brought into Florida from Michigan five years ago. This gives a good idea of the fecundity of this species. Animals are known to have escaped from ranchers in East Palatka, Gainesville, Tampa, and Summerfield. Two animals which escaped from a Gainesville rancher were killed within a short time after escape. One individual had moved about one mile from the point of escape before it was reported. At East Palatka one female escaped in December, 1956. Though the animal was never seen again its tracks were traced to a point several hundred yards away from the pens. At the Tampa locality escapes have occurred but additional information is lacking. The number of animals escaping from the Summerfield ranch is unknown but several escaped animals have been returned to the rancher by neighbors.

Summary and Conclusions

A combination of immigrants, escapees and released nutria appear to have given this exotic mammal a foothold in Florida. Feral records indicate that this species has entered northwest Florida from the region of the Mobile Delta and has immigrated south along the Gulf Coast to at least Levy County and possibly to Hillsborough County. Animals are known to have been purposely stocked at Blountstown and St. Petersburg while escapes from ranches have been reported from East Palatka, Gainesville, Summerfield and Tampa. Of the three major sources of wild nutria in the state, nutria ranches probably are of the greatest potential significance. Thirteen of the 20 nutria farms located in Florida are found in the approximate center of the state where lakes are very numerous and offer excellent habitat for the nutria. At the present time nutria interests in Florida appear to be actively engaged in the sale of breeding stock in an attempt to establish a pelting industry. A large state-wide feral population of this species would be a potential

threat to farm crops and waterfowl. Additional studies on the status of feral nutria and their effects on local ecology in Florida appear necessary.

Acknowledgments

The author wishes to express his sincere appreciation to Dr. James N. Layne, Department of Biology, University of Florida, who suggested this study and assisted in various ways. Thanks are also given to E. B. Chamberlain, Jr., E. Timmons and James Reed of the Florida Game and Fresh Water Fish Commission and to nutria ranchers F. C. DuBois, G. C. Streeter, Dick and Dee Fischbach and A. S. Stephens, Jr., all of whom provided most of the information collected for this paper.

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ANNOUNCEMENT

Twenty-second Annual Meeting

Florida Academy of Sciences

THURSDAY EVENING, DECEMBER 5

FRIDAY, DECEMBER 6

SATURDAY MORNING, DECEMBER 7, 1957

Stetson University

DELAND, FLORIDA

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THE QUARTERLY JOURNAL OF THE
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SCIENTIFIC METHOD AS A BASIS FOR THE NON-SECTARIAN TEACHING OF RELIGION

RALPH W. ODOM
Florida Southern College

One of my students recently expressed a very vital concern—she was training to be a teacher and would be expected, as she put it, to "teach religion" in the public school system where she hoped to find employment. But she was highly uncertain concerning her own religious beliefs, and she felt very insecure about trying to teach anything concerning the Bible and religion to youngsters. Whose interpretations would she teach? How could she say for sure that what she was teaching was the truth rather than some other way? How could she be fair to all groups—to the several varieties of Protestants, to Catholics, to Jews, and to those who professed no religious faith?

Throughout the country interest in these problems is widespread. Efforts are presently under way in many communities to include some form of religious instruction in the public schools. In 1955, the National Council of Churches sponsored a conference on Religion and Public education resulting in the issuance of a Study Document which has helped shape official pronouncements by many groups, both Christian and Jewish. (Hunt, 1956 : 21-52). Now statements, more or less official, are available from most major religious groups.

To illustrate the dominant place of this topic in the professional literature, the July-August, 1957, issue of *Religious Education* features a symposium of seven articles on the subject of religion and public education (1957 : 247-306), while the December, 1957, issue of the *International Journal of Religious Education* reports one teacher's efforts to integrate moral and spiritual values into a public school curriculum without offending either state or Federal law, or

any religious group in the community. (Trickey, 1957 : 9-11). Nor is the problem limited to the elementary level; the Fall, 1957, issue of *Religion in Life* carries a group of articles on the subject of religion in *higher* education. And doubtless many of the present hearers are familiar with the work of our own State Superintendent of Public Instruction, Thomas D. Bailey, on behalf of the teaching of the moral and spiritual foundations of our country in the public schools of Florida.

Throughout the country state supported colleges and universities are including courses in religion, sometimes under the English or Philosophy departments, sometimes as separate departments of religion where State law permits. Naturally such courses are expected to be non-sectarian in nature. But the private, even the church-related, schools are now in a similar position, for many denominationally sponsored schools enroll only a small percentage of students of their own religious faith, so that they, too, must think in terms of non-denominational teaching. A Baptist-related liberal arts college in Colorado where the present writer (a Methodist) has taught religion the past three years had among its students more Congregationalists, Presbyterians, Methodists, and Episcopalians than it had Baptists, and the Roman Catholics equalled the Baptists in number, with Jewish students not far behind.

If both our religious heritage and present day religious thought and practice are vitally important aspects of our total American culture, and thus ought to be a part of the formal education of our youth, then we must find a sound foundation on which to rest our teaching in order to make such values available to students of these varied religious backgrounds.

As we come now to our proposals concerning the non-sectarian teaching of religion we recognize that a variety of answers have already been given. For example, an official Presbyterian statement affirms the principle that "an educated populace needs to know the place and value of religion in American life," but asserts that this must be achieved in the schools with an attitude of "tolerance for all religious beliefs which involves an impartiality devoid of indoctrination." (Official Statement of the Presbyterian Church, U.S.A., 1957 : 28). A Jewish statement is skeptical about the possibility of achieving such freedom from bias, and advises particularly that "if discussion of religious doctrine arises in the classroom, the teacher should refer the children to home, church or synagogue

for interpretations." (The American Jewish Committee, 1955 : 6). The report of a committee of the American Council on Education points out that "tax-supported schools, colleges and universities cannot completely avoid religion," particularly in connection with such subjects as "history, literature, art and music," and advises as "most promising" the "factual study of religion when and where intrinsic to general education." (Committee on Religion and Education, 1953 : 82-83). Superintendent Bailey's approach recommends that the public schools teach for "appreciation and understanding" leaving the teaching for belief to the church and home. (Bailey, 1956 : 1-2).

Because of the required brevity of this paper, let it be noted that our remarks will be addressed mainly to the non-sectarian teaching of religion on the *college* level, with the suggestion that the same general approach is applicable on all levels.

"Scientific Method as a Basis for the Non-Sectarian Teaching of Religion" reads our title. And few would disagree with its implication that religion should be taught without denominational or sectarian bias. But the suggestion that scientific method is relevant to the field of religion many would question. Isn't religion, after all, mainly speculative in nature, not empirical? And doesn't it deal with the *non-verifiable* realm of values in contrast to the *verifiable* realm of facts? Isn't it concerned primarily with opinion, with belief, in contrast to knowledge with which other academic disciplines are concerned? There was a time when these charges were largely true, just as there was a time when chemistry was alchemy, but in our day there is no excuse for such nonsense, certainly not on the part of educated persons.

The rise of the sciences represented not merely a new approach to our physical world, but a new approach to the study of history, of society, of man, and of man's relationship to the larger whole of which he is a part. It was a spirit permeating all branches of learning and affecting all aspects of human behavior, including those which we call religious. And just as the sciences struggled to free themselves from ecclesiastical bigotry, religious thought and practice also struggled to free themselves from ecclesiastical bigotry, and with considerable success.

The late philosopher of religion, Edgar S. Brightman, of Boston University raised the questions: "Are any religious beliefs true? If so, which ones, and why? Are any religious value-claims truly

objective? If so, which ones, and why? The best possible answer to these questions," he contends, "is the best possible philosophy of religion." Indeed, religion is of little genuine significance in human life unless some "beliefs or value-claims are true," he continues and not merely matters of opinion; otherwise religion is "of primary importance only to phenomenologists or psychiatrists." (Brightman, 1940 : 116).

In the past hundred and fifty years there has developed in religion as in other fields (a) a vast body of factual *content,* or objective knowledge, and (b) a widely if not universally accepted *method.* And if the religionist can rarely get absolute certainty in answer to his questions, he is little worse off than the physical scientist, in whose realm accepted principles are always being overturned, and surely no worse off than the social scientist who generally concedes that a reasonably high degree of practical certainty, never absolute certainty, is the best that can be had.

Moreover, scientific method in religion is no less carefully defined and precise than in other areas of study. The scientific method is an overall attitude of careful, systematic, and open-minded inquiry. Its specific form varies, of course, with the subject matter of the particular field. In some branches of mathematics it involves mainly reasoning from supposedly self-evident theorems to their logical consequences. In chemistry or biology it involves the use of accepted laboratory techniques. In history it includes rules for the careful weighing of evidence and comparison of documents. And in religion the scientific method is no less precise. It is commonly known as the historical, or social-historical, method where it applies to biblical study, the history of religions, or the emergence of religious beliefs and practices. In the area of value-judgments and beliefs it is known as the method of philosophical investigation, and consists of the construction and verification of hypotheses to explain observed data almost exactly as in the physical or other social sciences.

Unfortunately there is not time here either to outline the various steps of historical inquiry or to describe the methods of verification used by religious philosophy. But the point we want to make is this: the scientific method as it applies to religion is both readily available and understandable by college students, and adaptable right on down to the earliest elementary school level. Granted that it is desirable to develop tolerant attitudes toward, and sincere

appreciation of, religions other than one's own, as most public school programs presently attempt to do, someone is inevitably going to ask the awkward question: "Yes, but which view is *really true?*" To answer, or even to imply, that there is no objective truth but only a variety of beliefs is to remove religion from any position of real effectiveness in human thought and behavior. Education with respect to our religious heritage and its relevance for today must go beyond this; it must equip the inquirer with tools for thinking, ways of intelligently constructing and verifying hypotheses, as in virtually every other field of inquiry.

"But aren't there dangers here?" the alarmist will immediately ask. "Can we trust children and young people to think intelligently? Wouldn't it be best if *we* gave them the answers to religious questions until they reached adulthood and were competent to think out their own conclusions? Suppose they should decide *against* the religious values we adults know to be important?"

Indoctrination, religious and political, has always been justified on precisely these grounds. Actually scientific method in religion performs several valuable services. In the first place, by espousing the ideal of the open-minded quest for *truth,* it elevates religion from a field characterized merely by a variety of beliefs or opinions to a reputable discipline in which genuine truth may be had. In the second place, far from destroying one's religion, it enables one intelligently to inquire into his religious faith. If, when subjected to the tests of truth, a previously held idea is demonstrated to be false, one is fortunate to make such a discovery and to replace it with a sounder view. But if it should be confirmed as true, one's previous idea then has additional support. In either case, one is gainer and not loser. Third, by equipping students with a method of thinking in religion instead of "giving answers" one stimulates the student to think out the best religious faith and practice for himself, rather than unquestioningly to adopt the views of others and thus get in the habit of handing over to others his most noble human characteristic—his ability to think.

Of course we ought to teach, and ourselves demonstate, genuine respect and appreciation for the ideas of others. Of course we ought not coerce or pressure students to accept our particular sectarian view. But beyond this, we have a responsibility to enable and encourage the learner *to think intelligently* in the field of religion as in every other field, and thus to find for himself that under-

standing of himself, his world, and his relationship to the larger whole which will enable him to move toward his own highest potential of life-fulfillment. Properly taught, the scientific method in religion, far from resulting in a cold and indifferent attitude, involves the student in the thrilling quest of understanding for himself life's most vital issues, and ultimately enables him to achieve an ever-growing faith, at once intellectually respectable and emotionally satisfying.

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A FIRST RECORD OF *OCTOPUS MACROPUS* RISSO FROM THE UNITED STATES WITH NOTES ON ITS BEHAVIOR, COLOR, FEEDING AND GONADS [1]

GILBERT L. VOSS
University of Miami
and
CRAIG PHILLIPS
Miami Seaquarium

INTRODUCTION

On December 19, 1955 Mr. Robert Still, a Miami shrimp fisherman, brought to the Miami Seaquarium a "red octopus with white spots" which he had taken in a shrimp trawl off Key Biscayne, Florida. The octopus was placed in an aquarium and held alive for a period of five months during which time its feeding habits, behavior, color patterns and other points of interest were observed by one of us (Phillips). At the time of capture the other author (Voss) was called to the Seaquarium to identify the octopus and at that time color notes, skin sculpture, and other features were observed. After a preliminary examination, the animal was considered to be an *Octopus macropus* Risso, the first specimen taken from the continental waters of the United States.

At the end of a short period of refusing to take food and an abnormal growth of the mantle, the animal died and it was turned over to The Marine Laboratory where one of us (Voss) made the positive identification and studied the specimen in detail. The following observations are a result of a combined effort by the authors to contribute to the biology and knowledge of this species upon which very little has been written.

The present paper had been finished when a second specimen, UMML Cat. No. 31.95, was turned over by the Seaquarium to the Marine Laboratory for study. The measurements and indices of this specimen, a male, have been incorporated in Tables 1 and 2 and pertinent information added where possible.

SYSTEMATICS AND DISTRIBUTION

Octopus macropus has been thoroughly dealt with systematically by two writers, Robson (1929) and Pickford (1945). These authors

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[1] Contribution No. 203 from The Marine Laboratory, University of Miami.

have described the general appearance and the former the distribution of the species, stating that it had a world wide range with the exception of the Americas. The latter author listed the species from various points in the Western Atlantic, notably Rio de Janeiro, Barbados, the Caribbean, Haiti and Bermuda.

The present specimen is the first record of this species from the continental waters of the United States, thus including the mainland in its range. The collector, Mr. Still, reported that he had taken another specimen from the same area the year before (1954) and thus it appears that it is a regular inhabitant of our coast. It is interesting to note, however, that both of the authors have collected extensively throughout the southeast coast of Florida and have not met this species in the shallow waters commonly occupied by *O. briareus, O. vulgaris* and *O. joubini.* The fact that *O. macropus* was taken in a shrimp trawl on both occasions points to a deeper habitat on our coast, probably 35-50 feet, the normal depth of shrimp trawling.

Besides the female specimen, UMML Cat. No. 31.73, seven other specimens of this species are in the collections, five from Cotton Cay, Cay Sal Bank, UMML 31.29, and two adults from Bimini, Bahamas and several immature and post-larval specimens from the Bahamas collected from fish stomach contents. Unless *O. verrilli* var. *palliata* Verrill from the Bahamas is *O. macropus,* as suspected by Pickford (1946) these are also the first records of this species from the Bahamas.

Table 1 gives the measurements of the Florida specimens and Table 2 gives the calculated indices as defined by Pickford (1945).

The arms are incomplete in the female but the male has the normal *O. macropus* arm order of 1.2.3.4. The web depth index is low, 12.7 and 11.1, slightly lower than that given by Pickford for the Bermuda specimen. A comparison of the other data with those given by Pickford are as follows. The MWI is comparable and is very variable in this species, but the head width index is very low in the female, 26.6 compared with Pickford's lowest of 32.5. The narrow head was striking in life as well as later when the specimen was preserved. The sucker index is low in the female, 6.9 as against 8.4, the lowest given by Pickford and that of the male is normal. The arm length is approximately the same but the mantle arm index is high in the female, 36.0 to Pickford's 25.5. The width arm index of 10.4 is also low in the female. Certain of these vari-

TABLE 1

MEASUREMENTS (IN MM) OF TWO SPECIMENS OF *OCTOPUS MACROPUS* RISSO FROM OFF BISCAYNE BAY, FLORIDA

Sex		Female	Male		Female	Male
TL		826.0	678.0	Arms I	624.0	583.0
ML		173.0	90.0	II	450.0—	526.0
MW		95.0	62.0	III	245.0	280.0
Web Sector	A	79.0	52.0	IV	516.0	435.0
	B	77.0	55.0	Sucker Diam.	12.0	10.0
	C	57.0	65.0	No. gill lamellae	12	12
	D	53.0	63.0	Arm width	18.0	16.0
	E	43.0	56.0			

TABLE 2

BODILY PROPORTIONS, SUCKERS, GILLS, ARMS AND WEB OF *OCTOPUS MACROPUS* RISSO

Sex	Female	Male		Female	Male
ML	173.0	90.0	Arm length	624.0	583.0
MWI	54.8	69.0	ALI	75.5	86.0
HWI	26.6	53.3	MAI	36.6	15.4
SIn.	6.9	11.1	AWI	10.4	17.8
Gills	12	12	WDI	12.7	11.1

TABLE 3

CHARACTERISTICS OF HECTOCOTYLUS AND PENIS OF A MALE SPECIMEN OF *OCTOPUS MACROPUS* RISSO FROM OFF BISCAYNE BAY, FLORIDA

ML	90.0	L.L.I.	6.8
H.A.	280.0	C.L.I.	13.2
Lig.	19.0	P.L.I.	12.0

ations in indices, especially those concerned with the mantle, are probably due to the elongation and inflation of this part of the specimen.

The male characteristics all vary from those listed by Pickford. The L.L.I. is higher and the C.L.I. and P.L.I. are lower. It is hoped that more specimens will be forthcoming from the Florida area.

In general, the body was long and distinctly oval, somewhat pointed posteriorly. The skin appeared smooth over the general surface and no bosses over the eyes were noted such as Pickford observed for other American specimens, and none were noticeable after death. However, during certain color phases as described later, large low ridge-like papillae appeared in a few rows along the dorsum of the mantle. A noticeable skin fold appeared on occasions extending along the dorso-lateral margins of each arm. Both of us noticed especially the long narrow pointed funnel which extended well beyond the level of the eyes.

General Biology

Behavior. Upon receipt at the Seaquarium the octopus was immediately moved for observation to a large open concrete holding tank. As the animal was experiencing difficulty in swimming and crawling from a quantity of air trapped within the mantle cavity, a certain amount of this was removed by holding the octopus underwater by the mantle with the funnel uppermost and massaging the body. All of the air could not be removed in this manner and it was not until the following morning that the octopus was seen to be free of all remaining air.

During the time that it was held free in the holding tank the animal alternately swam back and forth in the tank and rested at the bottom. As it was feared that it might escape while the exhibition tank was being prepared, it was held for two or three days in a heavy wire cage sunk at the bottom of the tank. During this period a considerable part of one of its arms disappeared and since there were no other marine animals in the tank it was assumed that this was eaten by the octopus itself.

An examination of the tips of the arms after death showed little evidence of regeneration even after a period of five months had elapsed. The end of the third right arm which had healed in normal fashion had a minute bud on the outer part about 1.0 mm in

length. The second left arm had also healed over but one sucker had assumed a directly terminal position and there was no evidence of regeneration. The end of the first left arm had apparently only recently been broken or eaten and healing had not as yet occurred.

Several days after capture the animal was moved to a glass-fronted, 350 gallon fiberglass exhibititon tank at the Seaquarium, where it remained until the time of its death, five months later. The tank was lighted during the day by three large fluorescent tubes (a combination of daylight and cool white) and a wire mesh screen was secured over the top to prevent escape. Other specimens in the tank included from time to time small specimens of *O. briareus* and about 12 small moray eels of the genera *Gymnothorax* and *Echidna.*

In its movements the specimen was seen to be less active than either *O. vulgaris* or *O. briareus,* a number of which had been kept from time to time under similar conditions. This included not only locomotion, but also respiration. When resting, the animal usually kept its arms bunched beneath it, showing a lesser tendency to coil them in an upward spiral than is common in the other two species. When touched, it usually responded by radiating all of its arms outward along the substrate in a creeping movement tips first, like the spokes of a wheel. Further stimulation usually induced it to swim through the water in normal octopus fashion, though more slowly, with the arms trailing behind it. Though the specimen was deliberately stimulated by hand in an effort to induce it to eject ink, results were completely negative.

The eyes had bar-shaped pupils which were usually dilated when active but when at rest the pupils were contracted to mere slits or completely closed in the center leaving minute apertures visible at either end.

During the day the octopus showed very little activity, spending most of its time on top of an eroded coral rock in the center of the floor of the tank, but it was seen to move about at night and during the early morning hours. The lights over the tanks were extinguished each night at 10:00 p.m. and turned on again at 8:00 a.m. In the early morning hours the octopus would often be seen moving about in the tank but as soon as the lights came on it would promptly come to rest atop the large rock or in one of the rock lined corners of the tank.

As mentioned above, there were other inhabitants of the tank.

It is interesting to note that the octopus paid little attention to the presence of the small moray eels, a normally important predator upon octopods. Should one of them approach too closely, it merely fended it off with one of its arms. It is possible that only large moray eels are predators on octopods and that no reaction was forthcoming from small ones although apparently inherent reactions occur among other animals on contact. An apparent instinctive reaction between the common squid, *Loligo pealei* held in a tank at the Shellfish Laboratory at Woods Hole and the blue crab, *Callinectes sapidus,* was observed by one of us (Voss). The crabs occasionally would catch a squid by the mantle in their claws. Contrary to expectation, the squid did not struggle but swept its tentacular suckers lightly over the crab's carapace, upon which the crab would release the squid instantly and scurry off. It is impossible to say whether this is an inherited reflex action caused by their hereditary enemy or due to some other cause.

The presence of the small octopuses caused a slightly greater negative response or retreat, but they in turn were highly disinclined to invade the territory of the octopus. No fighting or other direct interplay of action between these two species was noted, as in general they kept strictly out of each other's way.

About two months before its death, the specimen was seen to have acquired two superficial injuries over one eye. This was thought to have been caused by one of the morays, but the injury healed uneventfully and did not recur, despite the fact that the eels remained in the tank with the octopus.

During the first week in May it was reported by the tank attendants that the octopus apparently had not fed for several days since no fresh shrimp or crab shells had been found in the tank during that time. A close examination of the octopus showed it to be more sluggish in its movements than usual while its breathing was more labored and rapid than usual. Prodding it caused but little brightening in color pattern. Since the body appeared somewhat swollen it was thought that the animal was preparing to spawn, or else that it might have been overfed.

For another week and a half the apparent fasting continued and the body became more swollen. Movements, except for the accelerated breathing became very sluggish and the body hue gradually assumed a lifeless gray, and at this time a pathological condition was evident.

On the morning of May 13 the octopus was found dead by a tank attendant who, following prior orders, removed the specimen and placed it on a shelf in the aquarium freezer room. Later it was preserved and turned over to The Marine Laboratory Marine Museum for further study. The second specimen was not observed as closely but it also was secretive and nocturnal in behavior.

Habitat. Little is known about the habitat preferences of this species. According to Robson (1929), who cites various sources, it lives in the Mediterranean on rocky shores or on both rocky and sandy bottom. Pickford (1947), who studied the species in the Western Atlantic, states that the common octopus, *O. vulgaris,* is called the "Rock Scuttle" in Bermuda while *O. macropus* is called the "Grass Scuttle," but she draws no inference as to habitat from this.

The present specimen, coming from a shrimp trawl off Key Biscayne was almost positively living on soft mud and *Thalassia* or turtle grass bottom. The specimens from Cotton Cay, Cay Sal and the Bahamas had no habitat data included but from an account of the collecting they probably also came from shallow water *Thalassia* beds near shore. The second specimen was taken off lower Biscayne Bay in grass bed areas.

Food and Feeding. During its life in captivity, the octopus was never seen to feed and this probably took place at night. The tank was kept supplied with a number of shrimp, *Penaeus,* and small crabs, *Callinectes,* and the cleaned out shells of these were observed on the floor of the tank in the morning. By way of contrast, specimens of *O. vulgaris, O. briareus* and *O. joubini* kept in tanks at the aquarium all accepted live food quite readily in the daytime. No other food was given the animal while in the tank. There are apparently no observations in the literature on food or feeding of this species.

Color. Shortly after capture when seen by both of us in the holding tank the color varied from brick-red to pinkish-orange marked with a profusion of large white spots about one-half inch in greatest diameter on the mantle, head and arms, extending outwards on the latter to the tips. When at rest the spots faded out and became indistinct but returned when the animal was disturbed. After a month or two in the tank the original pinkish-orange and brick-red dulled to a dark red-brown, though the white spots still showed

very boldly when the octopus was active. When fully quiescent, the mantle assumed a drab brownish gray color against which the spots escaped notice under all but the closest scrutiny. The iris of the eyes remained a dull yellow. The same coloration and patterns were observed in the second specimen which had even more regular light spots.

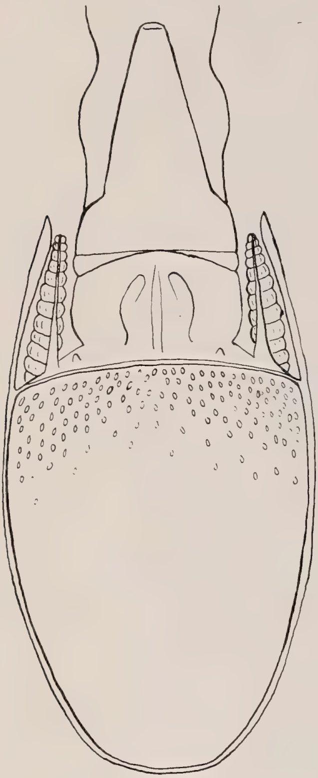

Figure 1. Semidiagrammatic illustration of the mantle cavity of the female *Octopus macropus* Risso from off Biscayne Bay, Florida. The transverse septum is prominent, but only a few of the eggs have been shown.

Internal Condition of the Mantle. When the specimen was brought into the laboratory for examination it was found to have a greatly distended mantle. On the dissection table the specimen was cut open with a pair of scissors. At the upper ¼ of the mantle the scissors met with an obstruction from a membrane and when this was punctured a large volume of discolored and vile smelling liquid was released, accompanied by large numbers of small eggs about 3 mm long and 1 mm wide. When the mantle cavity was laid open (Figure 1) it was found that the ovarium was greatly enlarged, occupying over ¾ of the mantle cavity and was now filled with a large number of decomposing eggs but still containing a solid mass of eggs about 60 mm in diameter.

In the process of distending the mantle, the viscera had been pressed together anteriorly until the same organs that normally occupy about ¾ of the mantle cavity now were contained in a restricted layer about 8 mm in thickness. In the same process, the membrane surrounding the ovaries had been pressed against the interior mantle wall until it had fused with the mantle wall throughout the posterior ¾ of the mantle and combining laterally with the membrane surrounding the viscera had formed

a thick, tough septum separating the ovaries from the exterior. An examination in detail of the posterior surface of the septum failed to reveal any trace of the gonoducts, and it is considered by the authors that the posterior or inner ends of the gonoducts had fused, thereby preventing the eggs from leaving the ovary and indeed sealing the latter organ with its developing eggs completely off from the external medium.

Even in non-copulating females the eggs, unfertilized, are laid in aquaria, though all soon decompose. In the present case it seems that death resulted from perhaps two causes. (1) the toxic effect of the decomposing eggs sealed within the mantle and (2) the extreme displacement of the internal organs. It is commonly reported that spawning female octopuses refuse food. While the present condition as described above is probably extreme, a squeezing together of the internal organs and displacement of the stomach may account for the inability to feed during this period and is seen in many other invertebrates.

Naef (1923 : 685) has shown a somewhat similar situation in a lesser degree in a Mediterranean *O. vulgaris.* He writes, "Reifes weibe vor der Eiablage, mit prall gefüllten ungeheuer vergrösserten Oovarium, durch das die übrigen Orange stark Bedrängt werden. Diese sind in möglichst natürlichen Lage dargestallt, doch ist der Mantelsack leider stark geschrumpft, so dass der ganze Abdominalsitus gegen dem Ausgang gequetscht wird. Man dencke sich dem Mantlesack hier immerhin wesentlich geräumiger und vergleich die vorhanded Figur." And on page 686, "Vor allem aber hat dass Oovarium eine ausserordentlichen Umfang erreicht und enthält etwa hundertaussend Eier (*O. vulgaris*). Dadurch wird die Topographie der Mantelhöhle stark gestört, wie die Fig. p. 685 zeigt. (Darin verhalten sich andere Octopodidae ganz gleich)."

Numerous other spawning females have been seen by the authors and one of us examined a good many in detail and no similar condition of the mantle has been seen. It is considered that this was probably a rare and pathologic condition and resulted in the death of the present specimen.

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Quart. Journ. Fla. Acad. Sci., 20(4), 1957.

RESEARCH NOTE

Additions to the Fishes Known from the Vicinity of Cedar Key, Florida

Two species of the family Carangidae are added to the list of fishes known from the vicinity of Cedar Key, Florida (Reid, 1954, Bull. Mar. Sci. Gulf & Caribb., 4(1) : 1-94. Caldwell, 1954, Quart. Jour. Fla. Acad. Sci., 17(3) : 182-184. Caldwell, 1955, *Ibid,* 18(1) : 48. Caldwell, 1957, *Ibid,* 20(2) : 126-128. Kilby, 1955, Tulane Stud. Zool., 2(8) : 175-247). These specimens are in the collections of the U. S. Fish and Wildlife Service's South Atlantic Fishery Investigations at Brunswick, Georgia.

Caranx ruber (Bloch). Jack crevalle or green jack. Two specimens, 129 and 137 mm. in standard length, were taken by the U. S. Fish and Wildlife Service M/V *Silver Bay,* Station 152, 29°01′ N., 83°21′ W., approximately 11 miles southwest of Cedar Key, August 21, 1957. This species has only rarely been reported from the northern Gulf of Mexico (Berry, MS, Fish. Bull. Fish & Wildl. Serv.).

Seriola dumerili (Risso). Great amberjack. One specimen, 150 mm. in standard length, was taken at *Silver Bay* Station 152 (data as above). Another, 250 mm. in standard length, was caught at Seahorse Reef, October 12, 1957, by Dr. E. Lowe Pierce, University of Florida. These identifications are based on the descriptions of Ginsburg (1952, Pub. Inst. Mar. Sci., 2(2) : 43-117). The nuchal band is vaguely visible on the 150-mm. specimen and extends from over the eye to the origin of the first dorsal fin; but it is not present on the 250-mm. specimen. The great amberjack is relatively common in the Gulf of Mexico, and visual accounts of amberjacks of over six feet in total length are probably attributable to this species.—Frederick H. Berry, U. S. Fish and Wildlife Service, Brunswick, Ga.

Quart. Journ. Fla. Acad. Sci., 20(4), 1957.

A NOTE ON AN UNUSUALLY COMPLETE SPECIMEN OF *DASYPUS BELLUS* (SIMPSON) FROM FLORIDA [1]

Walter Auffenberg
University of Florida

In 1956 Mr. Peter Drummond, a member of the Florida Speleological Society, discovered a Pleistocene deposit in Mefford Cave of more than usual interest. Of considerable importance is the fact that this locality has yielded remains of an extinct armadillo, *Dasypus bellus* (Simpson), more complete than any previously reported.

Mefford Cave, located approximately 1½ miles south of Reddick, Marion County, Florida, is a fairly large cavern in the Ocala limestone. Considerable "breakdown" covers most of the floor, so that the earth filling is unknown throughout most of the cave. In some of the deeper parts of the cavern the earthen floor has been recently eroded. The deposits which are thus revealed are composed largely of bedded brownish to reddish brown sand of presumed Pleistocene age and Miocene clay and residual marine fossils of the Hawthorne formation. In at least one fairly extensive pocket Pleistocene vertebrates are found in the bedded sandy earth.

Apparently the present entrance is fairly recent. During some interval of the Pleistocene a fissue near the vertebrate site was open to the surface and erosion carried the overlying Hawthorne formation, or its residuum, into the cavern. Following this, supposed Pleistocene sands and the remains of contemporary vertebrates were washed into the cavern, presumably through the fissure which has since become filled with rubble. The opening must have been large enough to allow animals at least the size of *Dasypus bellus* to pass through, since the position and nature of the specimen clearly indicate that it died nearby.

Continued filling of the cavern occured to some unknown date, when lowered water tables initiated another erosional cycle. This emptied large parts of the cave of its earthen contents; portions of which occur as erosional remnants in various parts of the cavern. Continued erosion brought about considerable collapse of the limestone walls and ceiling.

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[1] A contribution from The Department of Biology and The Florida State Museum, University of Florida.

In addition to the specimen of *Dasypus bellus,* remains of other vertebrates were found at the same locality and horizon. These include an excellent specimen of *Meleagris gallopavo,* the American Turkey, composed of an exceptionally fine skull and lower jaw, as well as associated parts of the post-cranial skeleton. In addition, scattered remains of *Testudo sellardsi* (?), *Equus* sp. and *Holmesina septentrionalis* have been found. Numerous remains of small reptiles and amphibians are also available from the same locality, but these have not yet been studied. On the basis of the available material there is little reason to postulate ecological conditions markedly different from those existing in the area at the present time, i.e., dry, open forest. On the other hand, there is no evidence to indicate that conditions have remained the same since deposition of the fossiliferous beds in the cavern. The deposit is presumed to be Late Pleistocene or early Post Pleistocene.

The fossil specimen of *Dasypus bellus,* forming the basis of this note (No. 2478, University of Florida Collections) hardly needs detailed description, since in almost all particulars, except size, the available partial and complete elements are identical to those of the Recent North American species, *Dasypus novemcinctus.*

Dasypus bellus was first described by Simpson (1929) from fragmentary material collected from the Pleistocene of Seminole Field, Pinellas County, Florida. The diagnostic character of the new species was stated as being largely a matter of size; averaging over twice that of the Recent form, *Dasypus novemcinctus,* and nearly equal to that of several extinct South American species. In 1931 Holmes and Simpson described the characteristics of isolated pieces of armor of *Dasypus bellus* on the basis of abundant scutes then available from Seminole Field, Florida. However, little direct evidence was available as to the arrangement and gross structure of the carapace, although it was assumed that *D. bellus* had nearly the same general appearance as that of *D. novemcinctus.* It is thus of interest that the shell of the present specimen of *Dasypus bellus* is sufficiently complete so that there is now no reason to doubt that the shape and disposition of the separate scutes of the carapace are different than they are in the Recent form.

The specimen from Mefford Cave is a mature female, attested by the fact that the remains of an unknown number of young were found within the confines of the carapace. The epiphyses of the specimen are not firmly co-ossified with the shafts of the bones of

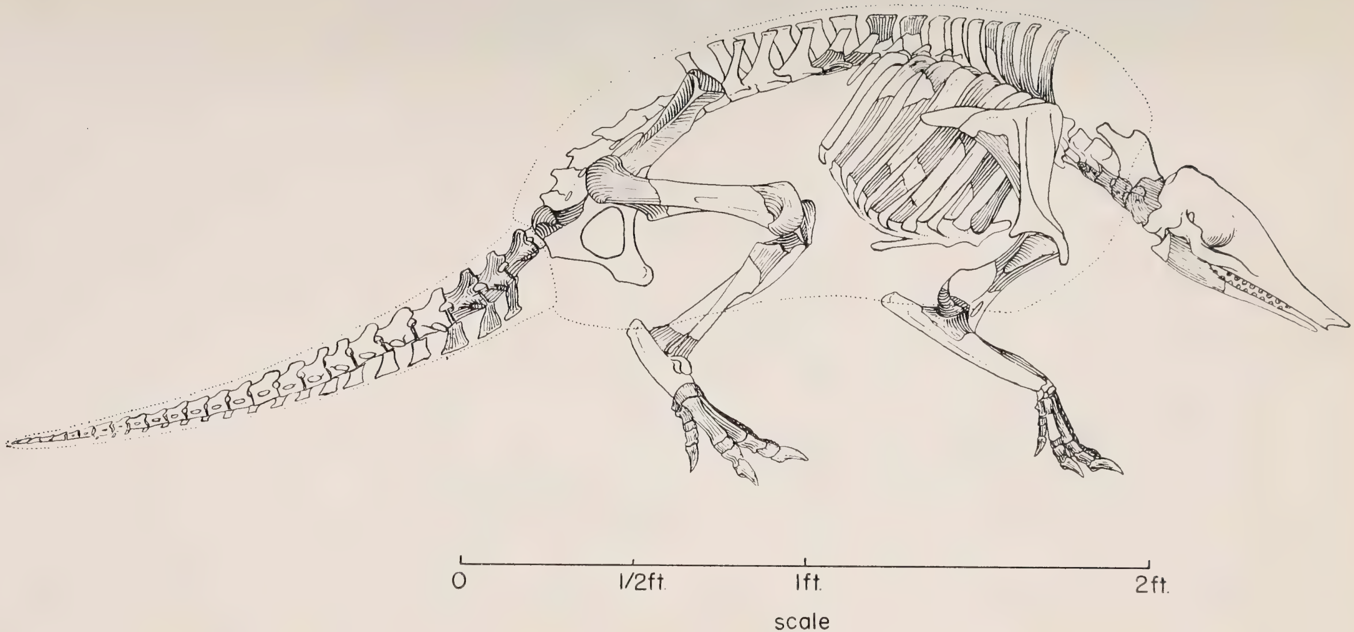

Figure 1. Reconstruction of *Dasypus bellus* (Simpson) based on U. F. 2478, an unusually complete specimen from Pleistocene or Post Pleistocene deposits of Mefford Cave, Marion County, Florida. Available skeletal elements are shaded. Although large portions of the carapace are available only the general shape of this structure is indicated by dotted lines.

the appendicular skeleton, suggesting that, though mature, it was not an old female.

The available remains of this individual include large numbers of both isolated and juxtaposed plates of the carapace, isolated teeth, part of each of the mandibles, a number of vertebrae, a complete hind foot with the exception of the calcaneum, and parts of the remaining feet, as well as the ends of most of the long bones and a number of fragmentary ribs (Fig. 1). Unfortunately, the caudal armor is represented by only a few isolated plates. Presuming proportions of the extinct and modern species of *Dasypus* to be nearly the same, the present specimen was about four feet long in life. Larger isolated plates from several other localities in Florida suggest that the species attained an even greater size, perhaps as large as five feet.

Simpson (1929) describes some of the teeth of this species in a jaw collected by C. P. Singleton at Melbourne, Florida. A number of isolated teeth are available in the present specimen. They differ in no regard from those of the modern species, or of those described by Simpson.

The posterior portion of both the left and right mandibles are available. Both fragments are provided with alveoli for the two most posterior teeth. The general shape of the available portions of these elements, plus that of the alveoli and the position and relative size of the mandibular foraman are identical to the same characters in the Recent species. The Melbourne specimen includes five teeth and an alveolus for another anterior to these.

The epiphyses and ends of the shafts of many of the long bones are available. They indicate no difference from those of Recent specimens of *D. novemcinctus,* except that they are considerably larger. The available ribs and girdle elements are also identical to those of *D. novemcinctus* in regards to general shape and proportions.

Of particular interest is the fact that almost the entire set of scutes making up the carapace is available, though most of the elements are isolated from one another. There are however, some fairly large sections of carapace available of this specimen in which all of the scutes are still connected. Holmes and Simpson (1931) have described the individual scutes of this form in considerable detail and there seems to be little reason to consider the isolated pieces of the present specimen to any great extent. There is, how-

ever, one statement made by Holmes and Simpson that requires comment. According to these authors the individual buckler scutes from Seminole Field were only occasionally provided with a follicle on the posterior margin of the primary scale. In the specimen from Mefford Cave one, or even two follicles in this area are quite common, agreeing with the modern species in this regard. In those sections of both the anterior and posterior bucklers which are available in the fossil specimen from Mefford Cave the ornamentation and distribution of the immovable scutes are identical to those in the same regions in the Recent species. The available articulated movable plates of the bands are also identical to those in the Recent species and to the isolated pieces described by Holmes and Simpson. The entire most posterior movable transverse band and adjacent immovable portion of the fossil specimen are available, indicating that, as in *D. novemcinctus,* there are approximately 31 members in each transverse band. In addition, large articulated portions of the remaining bands are also available. Nine peripheral band plates are available from the right side, indicating that the number of bands in *D. bellus* is probably the same as in the Recent species. Unfortunately, the carapace is not completely articulated, but a reconstruction based on the available articulated portions indicates that, like the remainder of the skeleton, *D. bellus* is very close to *D. novemcinctus.* In view of the greater variation in number of follicles on the posterior margin of the primary scale than was present in the material previously described from Seminole Field, the larger size of *Dasypus bellus* remains the only diagnostic character by which it can be readily distinguished from *Dasypus novemcinctus.* It is hoped that in the future a complete skull will be found, in which other diagnostic characters may become evident.

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SOME ANATOMICAL EFFECTS OF GIBBERELLIC ACID ON DWARF PEAS

Mildred M. Griffith
University of Florida

Gibberellic acid is a growth-promoting compound produced by the fungus, *Gibberella fujikuroi* (Saw.)Wr. This mold is pathogenic on rice and other grasses, and causes abnormal elongation of their seedlings. As early as 1926 a growth-promoting substance was reported in the culture filtrates of *Gibberella fujikuroi,* (Gray, 1957), but within the past few years its effects on a wide group of plants have been demonstrated. Gibberellic acid has been shown to accelerate seed germination and the growth of seedlings (Gray, 1957). It contributes to the breaking of dormancy of buds (Lona and Borghi, 1957), to induction of flowering, and to parthenocarpic development of fruits (Wittwer et al., 1957). However, the effect of this compound on stem elongation probably has received the major consideration. This effect has been attributed mainly to stimulation of cell elongation (Stowe and Yamaki, 1957), but gibberellic acid also has been shown to increase cell divisions (Sachs and Lang, 1957). No details of the effects of this compound on the anatomy of stems are available.

Methods and Materials

The effect of gibberellic acid on internodal elongation in dwarf pea seedlings was reported by Brian and Hemming (1955), and in the present paper their procedures are employed. Seeds of *Pisium sativa* (Little Marvel variety) were germinated in moist sand. After the development of the first leaves, the seedlings were transferred to test tubes of tap water. The seedlings were selected for uniformity in size and were supported in the tubes with cotton. Gibberellic acid was prepared in 95% alcohol in such concentration that a single drop from a hypodermic needle contained one microgram of the acid. Twenty four hours after the transfer, twenty of the plants were treated by placing one drop of gibberellic acid solution on a leaflet of the first true leaf. Twenty plants were maintained as controls. Within thirty six hours the treated plants were distinctly taller than the non-treated ones. After four days measurements of internodal length were made, and pieces of stems of treated and untreated plants were fixed in Craf III solution and processed

by the usual paraffin technique. Longitudinal and cross sections were microtomed at 10μ and stained with tannic acid-iron chloride and safranin. Macerations were prepared by treating pieces of stems with acid alcohol and ammonium oxalate.

Results and Discussion

The comparison in internodal length between seedlings four days after treatment with untreated seedlings is shown in figure 1. Little difference in root development was seen. Although the stems of the treated plants were conspicuously taller, elongation was not uniform throughout the seedlings. Measurements indicated that there was no significant effect on the first three internodes. Comparisons with measurements at the time of treatment indicated that this part of the stem had probably completed elongation at the time of the application of gibberellic acid. For this reason, the fifth internode was selected for examination, and comparisons in the anatomy of a number of treated and untreated plants were made. However, the measurements in this paper are based on the fifth internode of one treated and one untreated plant.

The length of the fifth internode in the untreated plant was .6 cm. and that of the treated plant was 2.7 cm, or 3.5 times longer. The cell lengths given in table 1 are based on averages of twenty five cells from each tissue. In each tissue, cells were significantly longer in the treated plant (fig. 3) than in the untreated plant (fig. 2), but never as great as 3.5 times. The longer internodes of the treated plants had not only longer cells but more cells longitudinally. These results seem to indicate that in internodes of dwarf peas, gibberellic acid stimulates division as well as elongation of cells. This is in accord with the observations of Sachs and Lang (1957) on mitoses in similarly treated plants of *Hyoscymus*. They found greater numbers of divisions in the subapical part of the meristem.

The effect of gibberellic acid on cell elongation is less in the epidermis than in other tissues of the stem (table 1). Because of this it is assumed that a greater number of divisions occurred in the precursors of these cells. Stomates were farther apart in treated plants. Here the average number of stomates per high power field was 7.6, but in the untreated plants an average of 13 stomates occurred in the same area.

TABLE 1. COMPARISON OF AVERAGE CELL LENGTHS IN TISSUES OF THE FIFTH INTERNODE OF TREATED AND UNTREATED PLANTS, FOUR DAYS AFTER APPLICATION OF GIBBERELLIC ACID.

	Untreated plants internode length—.6cm cell length in μ.	Treated plant internode length—2.7cm. cell length in μ.
epidermis	95	132
cortex	102	184
pith	154	446
pitted xylem cells	300	448

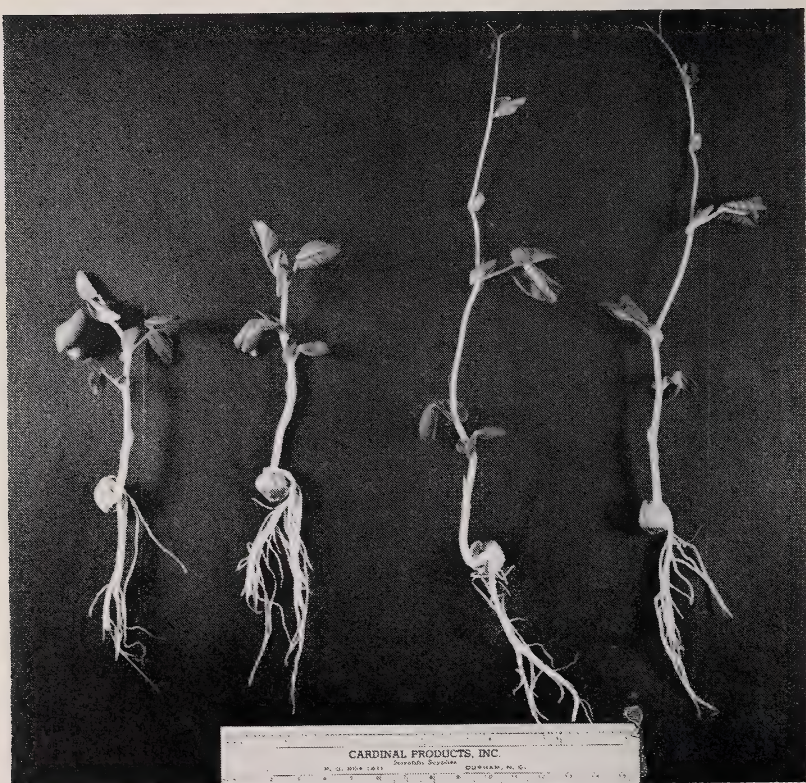

Figure. 1. Comparison betweeen untreated pea plants (left) and pea plants treated with gibberellic acid. Photograph taken four days after treatment.

Fig. 2. Longitudinal section of part of fifth internode of untreated pea plant. X120

Figure 3. Longitudinal section of part of fifth internode of treated pea plant. X120

The parenchyma cells of the cortex appeared much more vacuolate in treated plants and intercellular spaces were more prominent. Fewer plastids and starch grains occurred in the treated plants than in the controls.

A comparison of pitted elements in the xylem of treated and untreated plants shows that gibberellic acid has a distinct effect on the elongation of these cells. In addition, xylem of treated plants had a greater proportion of spiral and annular elements, but it was not possible to measure the lengths of these.

Pith cells of treated plants were very vacuolate as compared with the untreated plants. Also, in treated plants, pith cells are frequently torn, and in internodes where extreme elongation occurs the innermost pith cells are destroyed.

This study shows that gibberellic acid promotes cell elongation and causes an increase in the number of cells in certain internodes of dwarf peas. Neither of these effects is uniform in all tissues of an internode. The greatest proportionate elongation occurred in pith cells and the least in epidermal cells. There is evidence that gibberellic acid promotes the differentiation of protoxylem elements.

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INTER-FAITH ASPECTS OF COLLEGE DATING[1]

Earle E. Emme
Florida Southern College

Science magazine, in a recent editorial, "How to Be Interesting Though Factual", attempts to tell scientists how to report their researches, so that personal interest "Bailwick" becomes interesting and meaningful to the entire group. (Turner, 1957 : 901). Naturally the Florida Academy of Science members are included in this larger group to which he is writing. When religion invades the lively and age-long field of dating, no Academy of Science member is excluded. Those who have parental responsibility to and with high school and college students, are very likely to have had some specific experience in dealing with this topic. Guidance workers and most Academy members have counseled young people on some aspect of the problem-topic. It is not simply a matter of buying clothing, where young people go on their dates, what they do, whom they go with, what college, what vocation, etc., but many other issues keep coming up. These young people have been looking forward to these "romancing dating days" for some time.

A very recent volume on *Marriage and Family Living* states that "dating is not a unique American practice, but it is conducted in the United States with an *industry* and in a *volume duplicated nowhere* else in the world" (Fishbein & Kennedy, 1957 : 42). One of the recognized research leaders in this field, gives several very significant findings on general dating. In a recent study of 674 college students at Purdue University it was shown that the type of girl men select for dating when they are "playing the field" (dating a large number) is different from the one they are looking for as a mate later on. Other pertinent findings in this study include the following: 1) Males stress being affectionate and having physical attraction while women stress more sex standards and financial promise; 2) When selecting a mate these college students seek partners who are dependable and family minded; 3) Males seem to stress more than females, being a good home-maker (Christensen, 1950 : 256).

[1] This paper was read before the general session of the Florida Academy of Science, Stetson University, Dec. 7, 1957.

The above research reveals that there are valid experimental findings on the topic of general dating. Inter-Faith dating, however, a relatively new aspect of the topic of general dating, comes to the fore with its many unexplored interests, prejudices, perplexities, loyalties, and personal problems. In this latest aspect of dating, where religion enters the picture, the research findings are very sketchy and almost non-existent. Few if any significant studies have been made on such dating in either high school or college.

The College sample is well distributed. The 428 students from a Florida Church College of 3,000 students, are distributed evenly by college classes, age, dating activity, and only 45 more women than men. The samples were secured from classes in English, History, Speech, Literature, and a few in Education and Religion. 381 students are representatives of the following churches: Baptist, Methodist, Presbyterian, Roman Catholic (32), Episcopal, Jewish, Congregational, Lutheran, and Christian. The remaining were from Christian Science, Free Methodist, Reformed, Church of the Brethren, Latter Day Saints, Protestant Greek Orthodox, and Evangelical. Four indicated non-religion status, and 22 no membership but with a Protestant preference. This Florida college sample of 428 students had a wider geographical distribution than was at first supposed. 49% were from Florida but 51% was rather evenly distributed among the following states: Georgia, Alabama, New York, New Jersey, Pennsylvania, Massachusetts, Michigan, Illinois, Iowa, Wisconsin, Indiana, etc. While the sample is widely distributed geographically, it is very largely Protestant.

The following *check-list* was given to the classes of the departments indicated. Clearly stated at the top of the page was the phrase, "*No name, so answer frankly and fully*". Answers to the following topics were sought: college, class, age, sex, church affiliation or church preference if not a member, and number of dates per week the past 13 weeks (3 months). "*Briefly indicate the most important Inter-Faith Dating question or problem you have been thinking about and want solved.*" About the responses to this basic question center the major findings.

These 428 college students responded to the Inter-Faith Query as indicated in Table I.

The findings reveal that Inter-Faith Marriage questions head the frequency list, and that Inter-Faith Dating questions rank only third. Children (when children come) enter the picture, and parents

TABLE I

DISTRIBUTION OF INTER-FAITH DATING QUESTIONS AND PROBLEMS OF 428 COLLEGE STUDENTS.

Student Questions and Problems	Number	Percent
A. Inter-Faith Marriages	185	43
B. Engagement, no general dating, and no Inter-Faith Dating, cause 100 students to have no Inter-Faith question	100	23
C. Inter-Faith Dating	63	15
D. When Children are born	36	9
E. Vital Religion, Beliefs, Liberal and Conservative attitudes, reforming and converting others, etc.	20	4.1
F. Students resent parental comment, criticism, and objection to their Inter-Faith dating	16	4
G. Inter-Racial Inter-Faith dating and marriage	8	2
Total	428	100%

TABLE II

A. INTER-FAITH MARRIAGE QUESTIONS—43%

1. Settled: either take topic lightly or mate selected from similar religion	17	
2. "How successful are Inter-Faith Marriages?"	18	
3. Date to understand others	15	
Questions on Principles of Compromise		
4. Confident some solution can be reached	6	
5. After all, who is to give in?	13	
6. General ways of selecting a marriage plan	7	
Questions on Compromise between specific church groups		
7. Catholic-Protestant	62	
8. Catholic-Jewish	2	
9. Catholic and Non-religion believer	2	
10. Protestant-Jewish	5	
11. Protestantism (Denominations within)	22	
12. Protestantism—Non-believers and non-church or inactive	3	
13. Christian Science, Greek, Islam, and Buddhism	5	
14. Knowledge of all religions	2	
15. Marriage counsel, pre-marital, and Genetics	6	
Total	185	or 43%

later. Table I indicates that 43% of the students' questions related to Inter-Faith Marriages. The report of a high school study of 345 students revealed that only 30% of their questions related to Inter-Faith Marriages (Emme, 1958 : 179). The college questions in Table I will be considered in the order of frequency.

Table II shows the distribution of these Inter-Faith Marriage questions. To begin, why Inter-Faith Marriage questions when Inter-Faith Dating is the topic of this study with so much campus interest? Evidently a number are beginning to think of the end of their vigorous dating days, having fallen in love and now considering marriage. So some ask, "How successful can inter-faith marriages be?" Their urgent inquiry leads to a basic statement that cuts down through their questions: Inter-Faith marriages increase the divorce total. Landis (1957 : 153) gives this summary statement: "Where both parents were Catholic the divorce rate was lowest, only 4.4 percent of the marriages ending in divorce; if both were Protestant, 6.0 percent ended in divorce. If neither was religious, 17.9 percent ended in divorce. The highest divorce rate of all existed in marriages in which the husband was Catholic and the wife Protestant. Of this group 20.6 percent were divorced." Non-religion parents give the highest divorce rate. Weeks (1943 : 336) in analyzing the marital status of 6,548 families of public and parochial school children found the divorce rate to be increased to 23.9 percent, if there was no religion emphasized in the home.

To continue, thirteen questions on compromise, "Who is to give in?" leaves the inference that this involved marriage issue can be settled quite easily if one dating partner, or the other says, "O.K. with me!" Sixty-two questions were pointed at "Catholic-Protestant" issues, ranging from a ready willingness to surrender a faith, to the other extreme of uttering a sharp criticism of the Catholic church for its firm policies. These youths give no hint that these policies could have been known much earlier, and even during the early dating days. In evaluating this study, some sociologists and psychologists were surprised to find so many students with different views and anxiety within Protestantism (22). The liberal and conservative views, so militantly engaged in during the years 1918-1935, have evidently not died out among the homes from which these college students come.

A closing word on this large area of questions combines a conclusion and an implication. A positive conclusion imposes a terrific

responsibility upon the church and the home. These Protestant youth simply do not know the basic beliefs, rituals, and practices of the various faiths; nor have these young people indicated any understanding of the psychological personality factors involving these potential marriage-mates who cling to or disregard them. A salient leadership responsibility combines the insights of psychology and education. Some things need *to be learned in a vitally religious but tolerant setting rather early if the Inter-Faith Marriage Problem is to be solved during Inter-Faith Dating Days, especially before Engagement.*

The second ranking section of responses from the 428 college students brought forth 100 replies of a negative variety. In other words this group responded with no Inter-Faith Dating question; naturally the reason could be found in the data. The replies revealed that 51% of the 100 no-question responses indicated students who were engaged or had an understanding in some form; verbal, 30; diamond ring, 8; fraternity pin, 8; other jewelry, 5; the remaining 49 were distributed as follows: not dating, 22; dating once or less weekly, 20; seven said they would cross this bridge when they came to it.

The third largest area of questions relate to Inter-Faith Dating. An organization of questions resulted in the following topic questions:

1. Much disturbed but see no wrong in Inter-Faith dating	20	
2. Love is more important than religion; so will date and run the risk of falling in love	7	
3. Date freely to understand others and various Faith views	9	
4. Am much interested in one of a different faith	10	
5. One's religion influences the nature of dates	6	
6. Issues involved in Catholic-Protestant Faiths	6	
7. Sought dating and marriage counsel	5	
Total	63	or 15%

Two findings are very evident. Outside of topics six and seven, these college students are willing to run the risk of falling in love with an inter-faith partner. All this in spite of the fact that they possess little inter-faith information and still less understanding of personality factors in the union of two people. Secondly, their questions bear no relationship to the problems of general dating as

indicated earlier by Christensen. Character and qualities of personality that make for home stability were not questioned in any way. Certainly no inter-faith dating idealism will get very far if such qualities are not emphasized as basic to religious tolerance, goodwill, and religious dating ethics and standards.

To be more specific, basic dating activities sometimes include hetero-social plans for a date, to go to a dance, the movies, but no plans for the time after the first events. Landis (1957 : 71-72) is rather specific in saying: "Girls who wish to avoid extensive petting will recognize this possibility and will have plans in reserve to take care of the remainder of the evening. The most popular girls are those who have many different interests and can enjoy varied activities. These interests and activities are what boys are thinking of when they say it is not necessary for a girl to pet . . . Double dates with those who are in agreement on the subject are good solutions. Attending parties and other planned social activities also minimize the time when there is nothing to do."

This student omission of questions on dating standards is further accentuated by the fact that valid findings in several fields of investigation relate to pre-marital practices which later materially increase divorce, cause guilt, and various forms of unhappiness. Ehrmann's (1955 : 58) researches, typical of several, reveal the extent to which dating may go in hetero-sexual relationships on a college campus. Various forms of personality counseling by psychiatrists, medical advisers, marriage counselors, and other specialists, indicate that here is an area related to potential marriage unhappiness that can not be omitted from the more critical and analytical inter-faith dating considerations. Leaders in inter-faith counseling need to be aware of this college inter-faith dating blindness or omission.

Parents are involved in inter-faith situations with their sons and daughters in college. Cole (1954 : 314-316) divides parents into eight groups, ranging from being a "rejectant parent" to the more favorable "acceptant-democratic type". The nature of the four question-topics (see 3 and 4) would naturally distribute the parents among the eight different classifications. A doctoral research revealed that 243 Junior College students had considerable misunderstanding and difficulty with their parents relative to dates, college work, ideals, viewpoints, religion and finances. (Emme, 1932 : 65-66). The sixteen inter-faith questions were rather direct:

1.	Parental right to interfere is questioned	7
2.	I continue dating even though parents oppose	5
3.	How to get your parents to understand you	3
4.	Can parents disown those who marry a different faith	1
	Total	16

Items 1 and 2 reveal parents and their sons and daughters disagree positively, while the four remaining students were more conciliatory. It is rather clear that parental responsibility is divided here. High school students oppose parents rather violently and in a determined manner. A university public panel on inter-faith dating revealed that some college students proceed with their inter faith dating regardless of the attitude of their parents (Emme. 1950 : 8).

"When Children are Born", represents the next group of questions. Inter-Faith marriages often progress without difficulty. But with the preparation for, and arrival of the first child, the whole home atmosphere takes on a different perspective, urgency, and daily activity. The organized topics follow:

1.	Which church should train the children?	24
2.	Non-Catholics question Catholic instruction	10
3.	Children make the choice of church later	2
	Total	36

These Protestant college students were rather naive in their limited understanding of Catholic policies with respect to baptism, religious instruction of children, and the plan of mixed marriages (Total 24). Ten students questioned these policies in a caustic manner. Only two were given the privilege of making their choice of a religion or church. Landis reports parental policy on religious training in Protestant-Catholic marriages. The college students who were the products of Portestant-Catholic marriages were asked to describe the policy of their parents on religious instruction. A rank order of policies (highest to lowest) follows (Landis, 1957 : 156).

1.	Mother took all the responsibility for the religious training	36%
2.	Our parents told us about both faiths but let us decide for ourselves when we were old enough	27%

3. The responsibility for religious instruction was equally divided between the parents 20%
4. We took turns going to both the church of my father and my mother 7%
5. Father took all the responsibility for the religious training 4%
6. Some of us went with my father to his church and some went with my mother to her church 3%

Landis goes on to indicate that the mother influence is strongly observable. But he points out that the "Catholic father's insistence upon having a place in the religious instruction of the children may be one factor explaining the high divorce rate when Catholic men marry Protestant women".

Leiffer (1949 : 107) confirms this dominant role of the mother in his study of 305 mixed religion families, that over half of the children are related to the mother's church; and the next most frequent allegiance being to the church of the father. Leiffer adds "the evidence seems clear that the mother is more important than the denomination in determining the allegiance of the children."

Summary

1. 43% of the questions of 428 college students related to inter-faith marriages.
2. Only 15% of the questions centered in inter-faith Dating. Inquiry concerning significant stabilizing personality, home-making, and hetero-social relationships were lacking.
3. Parental advice was very largely disregarded.
4. Inter-Faith information was strikingly limited.
5. The prevailing tendency seems to be that college youth continue to enjoy their romancing dating days and think very little of Inter-Faith issues until it is time to make wedding plans.

Implications and Suggestions

1. It would seem that valid findings on inter-faith marriages and dating should be given to youth before "falling in love" takes place.
2. Following methods have been used successfully: "Family Living Courses" in High School; public panels; church groups of young people making some use of trained leaders in this field.

3. Leadership attitudes in the presentation of such facts should be objective, tolerant and appreciative of other faiths.

A Scientific Inter-Faith Dating Hope!

Inasmuch as 43% of the inter-faith questions of college students centered about inter-faith marriages, revealing that they are woefully ignorant of the facts, it would seem that further delay of investigation in this vital home-planning area should be arrested by a re-examination of the following findings revealed in or suggested by this study:

Inter-faith marriage difficulties (pitfalls) should be investigated and understood. Duvall (1957 : 145) and Landis (1957 : 156) give selected findings on mixed religion, divorce, religious difficulties etc. Suggestive of eleven major difficulties, Emme (1958 : 183) points out a few of the salient issues: 1) Inter-faith marriages increase the divorce rate from six to twenty-seven percent; 2) Children give the major marriage difficulty, etc.

Yes, children impose the supreme test of inter-faith marriages for their parents when they ask a religion question of one parent concerning the religion of the other parent. The father, in answering, even though sincere, wants to answer fully but is untrained and uninformed upon his mate's religion. He wants to keep the confidence of the child and protect his love for his mate and protect her religion. . . . all at the same time. Five (5) difficulties. The mother when answering, has similar difficulties. But it is much worse when both parents, being present, disagreeing, face the child's question. Here are five issues plus two. These are meagre findings but youth needs to face such reality issues!

In conclusion, this study reveals that many college students are drifting along as a tumble weed in the wind . . . . but they drift within enjoyable "inter-faith love friendships" regardless of religious beliefs, practices, emotional maturity, or vocational preparation. At a later time inter-faith dating issues are certain to arise when wedding plans are considered.

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NOTES ON GAMETANGIA IN *UDOTEA*

Ronald C. Phillips
Florida State Board of Conservation Marine Laboratory[1]

The algal genera comprising the family Codiaceae are common constituents in the marine tropical flora of the West Indian-Florida region. The morphology of these plants has been relatively carefully studied. The reproduction of the Codiaceae is, however, practically unknown.

Fritsch (1948) states that vegetative propagation is probably widespread in the family. In *Codium* vegetative propagules have been found on the vesicles. In addition *Codium* and *Halimeda* are the only genera in which sexual reproduction has been reported. Sporangia have been observed growing terminally on the blade in *Avrainvillea* (Fritsch, 1948). Reproductive organs were accorded long ago to *Udotea* and *Penicillus.* These later proved to be epiphytic organisms (Ernst, 1904).

In a recent collection from the mouth of the Anclote River near Tarpon Springs, Florida, one plant was identified as *Udotea cyathiformis* Decaisne. The plant was not a typical one. Instead of the typical cyathiform habit, the flabellum was an expanded blade. The blade was greenish, split, and much lacerated. The plant is extraordinarily large for the typical specimen: stipe length—5 cm.; stipe width at top—9 mm.; stipe width at bottom—4 mm.; blade height—8 cm.; blade width—9 cm.; overall plant height—13 cm.

A cursory examination of the flabellar filaments revealed a small ovoid body at the apex of one filament (Fig. 1). The appearance immediately suggested a similarity to the female gametangia of *Codium.* The organ was dark green, packed practically solid with roundish bodies, each densely green with chloroplasts. The length of the organ was 66 microns, the greatest width was 35 microns. By means of oil immersion magnification a wall was seen at the base of the organ. The wall was thinnest in the middle. At this thinnest point cytoplasmic strands could be seen passing through the wall from the organ to the filament. Possibly the wall is newly formed.

The wall at the organ base does not possess the thickness that is produced by the filament walls at the constriction above a dichot-

[1] Contribution No. 7 from The Fla. State Board of Conservation Marine Laboratory, St. Petersburg, Florida.

omy. In a filament the wall never closes off the continuity of the cell passage. The organ basal wall seems to isolate the organ from the filament except for the cytoplasmic strands. The probability that this wall arises by ingrowth of the filament walls at the organ base is not intended to be ruled out, however, the inference is that the origin of the basal wall is not identical with that at a filament constriction.

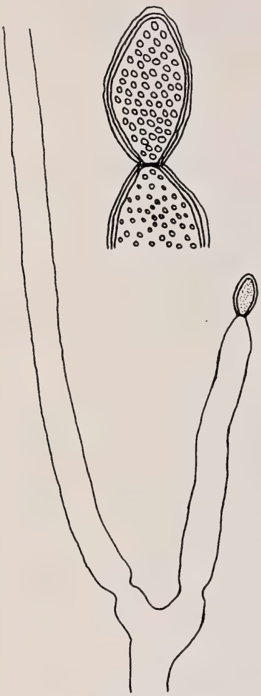

Fig. 1. Flabellar filament with gametangium at apex (X87), and enlarged view of gametangium (X325).

In the genus the filaments of the blade branch dichotomously. The possibility suggested itself that this organ might be a normal growth phenomenon with the other new filament of the dichotomy broken off. However, as Figure 1 shows, the filament constriction arises above the point of dichotomy. No dichotomy is present here which would correspond to a filament branching. In addition at no place near the organ could traces be found of another filament growth having broken off. It is, therefore, considered that this organ is located at the terminal position on the filament and is not a continuation of vegetative growth.

A membrane surrounds the gametangium wall and extends over the apex of the gametangium to form a chamber (Fig. 1).

The organ observed is considered to be a female gametangium. It was the only one seen.

The plant was collected by Mr. Kenneth Woodburn, biologist, of the Florida State Board of Conservation Marine Laboratory. Sincere appreciation is accorded to Dr. Robert F. Hutton and Dr. Victor Springer of the Marine Laboratory for their helpful criticism and remarks.

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A NEW, LARGE CILIATE FROM WARM MINERAL SPRINGS[1]

James B. Lackey
University of Florida

About two miles south of the bridge where U. S. 41 crosses the Myakka River in Sarasota County, a large first magnitude spring emerges from a deep boil. This was formerly called Warm Salt Springs (Ferguson, et. al., 1947) but the present developer of the area seems to have changed its name to Warm Mineral Springs as of June, 1954. The flow is between seven and nine million gallons per day of water which has a constant temperature of 86° F., contains no dissolved oxygen, but does contain 0.162 parts per million of hydrogen sulfide. It also contains about 17,000 parts per million of dissolved solids, the principal components of which are shown in Tables I and II. According to Odum (1953), there are .033 parts per million of inorganic phosphorus in the water, and .050 of total phosphorus.

TABLE I

ANALYSIS OF PARTIAL SOLIDS IN WARM MINERAL SPRINGS PARTS PER MILLION

	Ferguson, et al	Morgan
Dissolved Solids	17,812.00	17,988.00
Iron	0.12	0.09
Calcium	766.00	596.00
Magnesium	471.00	567.00
Silica (SiO_2)	18.00	23.80
Sodium, Potassium	5,124.00	
Chloride	9,350.00	
Bicarbonate (HCO_3)		167.00
Total Hardness ($CaCO_3$)	3,846.00	

These features are part of an environment which is virtually constant and contains about half as much salt as sea water although not in the same composition. As such, the Springs should have a unique biota, and this is the case. There is a limited number of blue green algae and almost no green algae, except slight growths of *Spirogyra, Vaucheria,* and *Oedogonium.* Amoebeae and flagellates are poorly

[1] Work supported by a grant-in-aid from the National Institutes of Health.

represented, although one species of *Euglena* and several colorless genera of Euglenophyceae occur. Ciliates, however, are abundant and include some unusual fresh water species such as *Condylostoma, Saprodinium,* and *Frontonia.* There are also some distinctly salt water forms such as *Diophrys, Uronychia,* and *Uronema pleuricaudatum.* Then there are ubiquitous forms such as *Cyclidium* and, finally, one or more species of H_2S tolerant types such as *Metopus.* In short, there is an unusual ciliate fauna and it is not surprising that new species should be encountered.

TABLE II

CERTAIN PHYSICO-CHEMICAL CHARACTERISTICS OF WARM MINERAL SPRINGS

Temperature	84°F	± 2°
pH	7.2	± .2
Volatile Solids	17.1%	(600°C for 30 minutes)
Nitrate (NO_3)	0.05	ppm
Dissolved PO_4	0.0016	ppm
Total PO_4	0.0037	ppm
Chemical Oxygen Demand (Dichromate)	813.0	ppm
Dissolved Oxygen	0.0	ppm
H_2S	0.162	ppm
HS	0.078	ppm
Sulfate (SO_4)	1,704.0	ppm

Kahl (1933) established the family Geleiidae and the genus *Geleia* for three new species he found in the sand at Kiel. His organisms were, therefore, marine and belonged to the category of sand dwelling ciliates described also by Faure-Fremiet (1950-1951), Noland (1937), and others. *Geleia* is characterized as elongately stretched, strongly contractile, having a mouth which is a long flat pit, close to the anterior end, and on the left of the broad side. Kahl's largest species, *decolor,* is 600-800μ in length and colorless to pale yellow. The color of his smallest species, *nigriceps,* is not given except for small black granules in the anterior end. It is 200-300μ in length; *fossata* is 300-400μ in length and is brownish yellow. As far as known, there has been no reference in the subsequent literature to any of these species.

Faure-Fremiet added two additional species in 1950 and 1951. His first, *G. orbis,* attains a length of 1700μ, is cylindrical in cross sec-

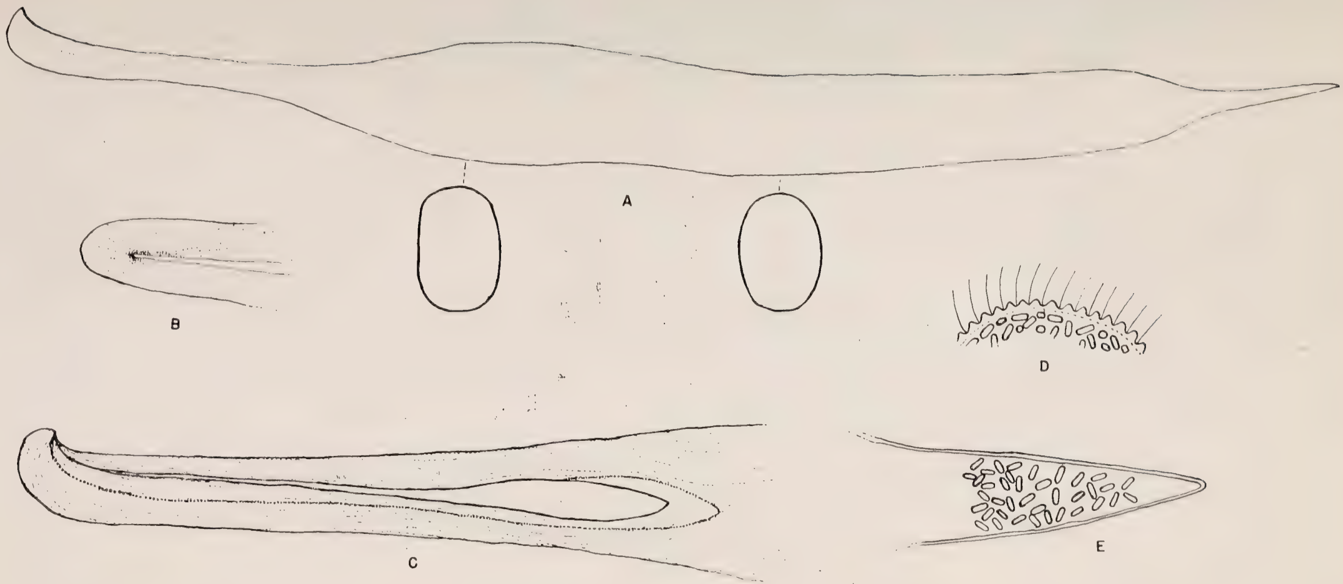

Figure 1. (a) Usual body shape of *Geleia floridensis* sp. nov. Note the two projected cross sections through the body. (b) Ventral view of beak region showing the anterior end of the mouth slit and the ciliation pattern. (c) Mouth slit, its posterior enlargement and the backward internal extension to form a gullet. (d) Optical section to show ridges between the ciliary grooves and the thickness of the pellicle. The peripheral location of the bacteroid-like bodies is indicated. (e) The posterior end, where the bacteroid-like bodies are most easily seen. Illustrations (b) and (c) are approximately three times the magnification of (a), and (d) and (e) are approximately four times the magnification of (a).

tion, and strongly thigmotactic. It is best characterized by very pronounced serpent-like writhings. He reported this one from Europe but also found it at Barnstable on Cape Cod, whence came his second species, *G. simplex.* This one is 206-300μ long and has no anterior prebuccal lobe. Its color is not given.

Among the unidentified ciliates from warm mineral springs is one which at times attained a length of 2 millimeters. Never too abundant, it is sufficiently common for study. It has been determined to be a *Geleia* and the species name, *floridensis,* is proposed for it.

Geleia floridensis n. sp.

The new species, so far found only in Warm Mineral Springs, shown in Figure 1A, is 1400-2000μ in length and is so dark brown in color as to obscure internal details. There is a pointed tail region, which may constitute ⅕ of the length, and a long neck region about ¼ to ⅓ total length. The trunk section of the body is oval in cross section rather than flat but the neck region is distinctly flattened and narrowed. In front there is an overhang, which occasionally is beaked. Beneath this beak or overhang the slit of the mouth begins, 1B, and may extend back about 200μ. Often, at its distal end, it is held open, 1C, as the animal moves around. Underneath the lips a gullet-like sac extends back. The mouth and beak are usually on the right when the organism is seen from above. In this respect it is more like Kahl's *Remanella,* five species of which were described by him in 1933, also from Kiel.

The body is uniformly ciliated, all cilia being short, slender, and 5-10μ long, the longest ones in the beak region and along the mouth slit. They emerge from furrows, 1D, in the thick pellicle. No trichocysts have been demonstrated by crushing or on death. The margin of the mouth is smooth. However, the cytoplasm beneath the pellicle, 1D, E, is filled with short rod-like bodies not arranged in any particular pattern. They are of rather uniform size and resemble bacteroids more than anything else. They persist after the animal is crushed. No other internal structure—nucleus or food vacuole—is evident because of the deep brown color. There are no contractile vacuoles.

The deeper parts of the cytoplasm contain many spherical bodies which appear to be a very light oil because on crushing, they are extruded with the bacteroid-like bodies and persist, not being misci-

ble with water. They do not leave a visible oily stain. The cytoplasm is very slightly brown but along the pellicular ridges are rows of very small but deep brown granules, of irregular size and, within the row, of somewhat irregular elongate distribution. Apparently there are enough of these to help color the organism.

Most of those found have been taken in loose debris or in clumps of algal material, not deep in the sand. The organisms occur in some abundance, moving slowly through the debris, turning and at times contracting to about three fourths of their extended length. In hanging drops, they rarely last more than two days but in jars of Warm Mineral Springs water kept at 80° F. and with algae, *Nitella,* and debris, they have been found for a month after the sample was brought in. When one is crushed, the brown color disappears at once and there are no vestiges of the nucleus to be seen. Crushed animals have been found to contain two or more species of diatom shells, filamentous blue green algal fragments, and *Chroococcus* as well as some amorphous matter. No division stages have been seen.

On the basis of size, relatively constant morphology and color, as well as habitat, it is considered that this is a new species. The contour of the neck region is distinctly different from described species and also from *Remanella.* The species is always dark brown never bright yellow, as is sometimes the case of *G. decolor,* according to Kahl; *decolor* approaches this one in size but it has a wide neck with a rounded caudel end which does, however, termniate in a blunt point. *G. orbis* is nearest in length but is uniformly cylindrical in cross section, is more strongly thigmotactic. *Floridensis* is very deliberate in movement and never given to serpent-like writhings. No "Mullers bodies" have been found and there is no skeletal apparatus as in *Remanella.* The mouth is wholly different from that of *Loxodes.* Altogether the organism appears to be a *Geleia* and a new one.

The group may be characterized as follows:

Family Geleiidae. Kahl 1933.

Genus Geleia. Kahl 1933.

Organisms 200-300μ long. No anterior beak. Mouth lateral.

Black granules in anterior end. *G. nigricans* Kahl 1933.

No black granules in anterior end. Mouth nearly apical.

G. simplex Faure-Fremiet 1951.

Organisms 300-400μ long. Beak small. Mouth slit, short. Brownish yellow. *G. fossata* Kahl 1933.

Organisms 600-800μ long. Neck wide, beak poorly defined. Colorless to golden yellow. *G. decolor* Kahl 1933.

Organisms to 1700μ. Serpent-like. *G. orbis* Faure-Fremiet 1950.

Organisms 1400-2000μ long. Neck narrow, beak sharply defined, mouth slit long. Dark brown. *G. floridensis* Lackey 1957.

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A CORRECTION

A list and bibliography of the mammals of Florida, living and extinct, Sherman, 1952, vol. 15, pages 92 and 93 of this journal lists *Peromyscus gossypinus*, *Peromyscus floridanus* and *Pitymys pinetorum* as being recorded from the Pleistocene. No literature cited supports these records. They were erroneously and unintentionally included as a result of having information of unpublished manuscript by Mr. H. James Gut, a rare gentleman and a good friend.

H. B. Sherman, DeLand, Florida

Quart. Journ. Fla. Acad. Sci., 20(4), 1957.

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